IRD

641

Installation
Operation
&
Service Instructions
for
MECHANALYSIS
MODELS 1224 & 1225
VIBRATION MONITORS

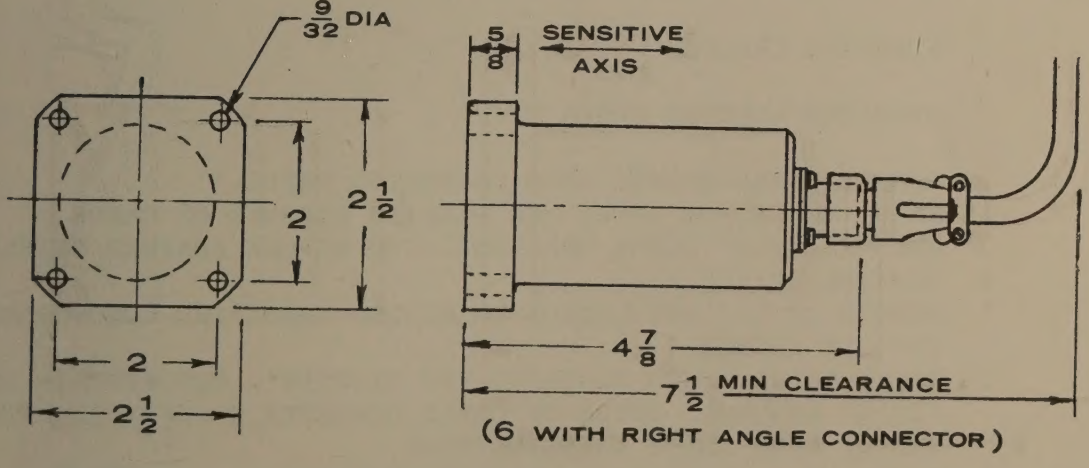
ADDENDUM

IRD Mechanalysis has recently introduced the Model 544M Vibration Pickup specifically for use in permanent installations. The 544M Pickup has a 4-hole base to provide secure mounting on any machine surface, and the signal coil is electrically insulated from the pickup shell to preclude "ground loop" problems in installations where stray ground currents are present.

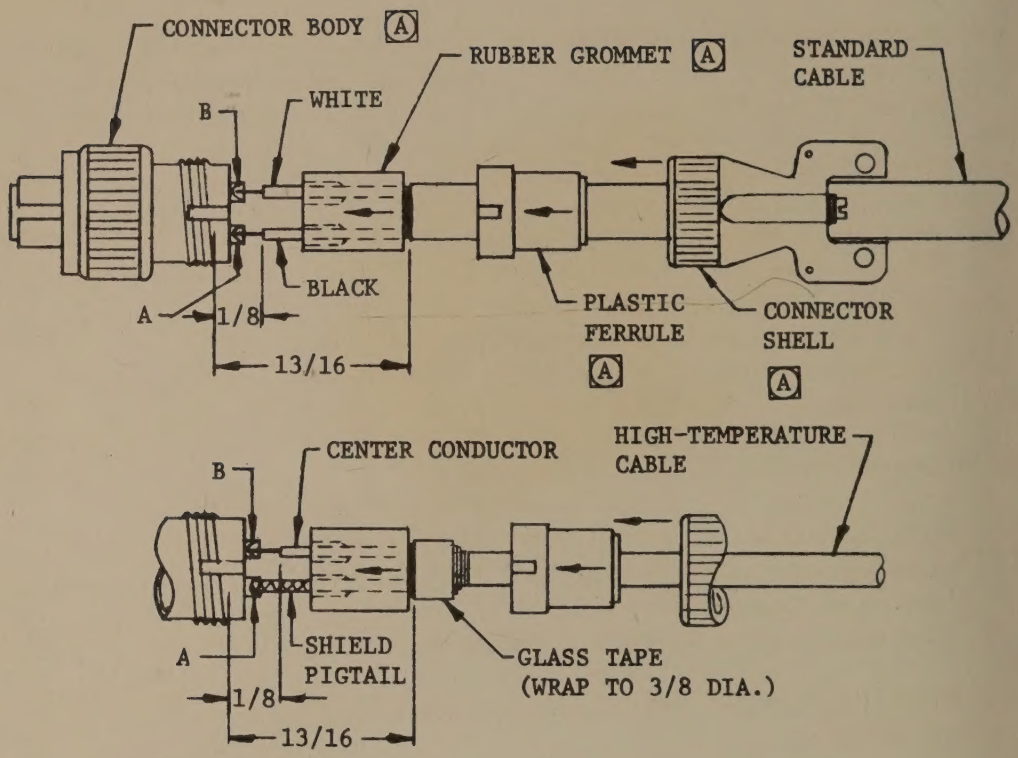
When installing the 544M Pickup provided with your instrument, use the following mounting and cable assembly instructions instead of those found in the Instruction Manual.

PICKUP MOUNTING

The Model 544M Pickup has four 9/32 Diameter holes on 2 x 2 inch centers in the end plate, to fit 1/4 Diameter machine screws. The surface on which the pickup is mounted should be smooth and flat so the pickup makes good contact. If a bracket is used, it should be rugged and have a resonant frequency several times higher than the rotating frequency of the machine.



CABLE ASSEMBLY



(A) PART OF CONNECTOR ASSEMBLY

ASSEMBLY INSTRUCTIONS

STANDARD CABLE	HIGH-TEMPERATURE CABLE	
1	1	REMOVE CABLE CLAMPS FROM CONNECTOR SHELL.
2	2	SLIDE CONNECTOR SHELL AND PLASTIC FERRULE ON CABLE.
3	3	REMOVE 13/16" OUTER INSULATION TO EXPOSE BRAIDED SHIELD.
4	4	UNRAVEL SHIELD.
5	5	REMOVE 13/16" INSULATION TO EXPOSE INSULATED CONDUCTOR(S).
6		CUT OFF SHIELD.
	6	TWIST SHIELD INTO PIGTAIL, TIN LIGHTLY*, CUT PIGTAIL TO 13/16" LENGTH. BUILD UP CABLE DIAMETER TO 3/8" IN AREA SHOWN, WITH GLASS ADHESIVE TAPE.
7	7	STRIP 1/8" INSULATION FROM END OF LEAD(S), AND TIN.*

ASSEMBLY INSTRUCTIONS CONTINUED

STANDARD CABLE	HIGH-TEMPERATURE CABLE	
8	8	INSERT LEADS IN RUBBER GROMMET (LARGE HOLES OF GROMMET TOWARD CONNECTOR BODY). PUSH GROMMET TOWARD FERRULE.
9	9	SOLDER LEADS TO CONNECTOR PINS.*
10	10	COAT SOLDER CONNECTIONS WITH SILICONE COMPOUND. PUSH GROMMET UP FLUSH WITH REAR OF CONNECTOR BODY. COAT GROMMET AND EXPOSED LEADS LIBERALLY WITH SILICONE COMPOUND, THEN SLIDE FERRULE OVER GROMMET. (ALIGN FERRULE KEY WITH CONNECTOR KEYWAY.)
11	11	COAT CONNECTOR THREADS WITH LOCTITE GRADE B, OR EQUIVALENT. SLIDE CONNECTOR SHELL OVER FERRULE AND THREAD ONTO CONNECTOR. TIGHTEN FIRMLY.
12		INSTALL CABLE CLAMPS AND TIGHTEN CLAMP SCREWS.
	12	INSTALL CABLE CLAMPS OVER TAPE AND TIGHTEN CLAMP SCREWS.

* USE 60/40 FLUX-WIRE OR HIGH-TEMPERATURE ROSIN CORE SOLDER, AS APPROPRIATE

Installation
Operation
&
Service Instructions
for
MECHANALYSIS
MODELS 1224 & 1225
VIBRATION MONITORS

This Handbook is applicable to Monitors having serial-number prefix letter B and subsequent.

Machinery vibration levels at which Mechanalysis Monitor "Warning" and "Shutdown" functions are to occur are to be established by the Customer, in accordance with his experience and/or the recommendations of the manufacturer of the equipment to be monitored.

The Mechanalysis basic Audio–Visual Training School and Advanced Training School are available without charge to Customers having Mechanalysis Vibration Analysis Instruments. Basic Audio–Visual Training Schools are scheduled periodically in all Mechanalysis Districts. Advanced Training Schools are available regularly. These schools provide the necessary skills for utilizing vibration as the key for determining machinery condition.

IRD MECHANALYSIS, INC.

SUBSIDIARY OF H. H. ROBERTSON COMPANY

6150 HUNTLEY RD. COLUMBUS, OHIO 43229

PHONE: 614/885-5376 CABLE ADDRESS: IRDMECH, USA

#1108A Copyright 1971 IRD MECHANALYSIS, INC., Columbus, Ohio. Subject to change without notice. Litho in USA.

WARRANTY

All IRD MECHANALYSIS, INC. products are warranted to be free of defects in materials and workmanship for a period of one year after shipment. In case of failure, IRD Mechanalysis, Inc.'s liability shall be limited to furnishing, but not installing necessary repair parts, or at the option of IRD Mechanalysis, to repairing the defective product at its plant in Columbus, Ohio or authorized repair center, providing the equipment is returned to the factory at Buyer's expense.

This warranty does not apply to equipment showing abuse or damage or to equipment which has been altered or repaired by others, except as authorized by IRD Mechanalysis, Inc. nor does it extend to products which have been subjected to a corrosive and/or abnormal atmosphere, or product components (such as batteries, lamps, etc.) which have provided a normal service life.

In no event will responsibility be assumed or implied for consequential damages arising from interrupted operation or any other causes. Vibration levels and/or tolerances must be established by the Buyer.

This warranty is in lieu of all other warranties express or implied and no one is authorized to assume any liability on behalf of IRD Mechanalysis, Inc. or to impose any obligation on it in connection with the sale of equipment other than as stated above.

CLAIMS FOR LOSS OR DAMAGE IN TRANSIT:

The risk of loss or damage in transit shall be on the Buyer, and Seller's responsibility with respect to such loss or damage shall be to supply the Buyer with copies of the shipping documents necessary for the Buyer to establish its ownership in the goods.

All products should be inspected and operationally tested immediately after receipt by the purchaser. Claims for damages occurring in shipment must be made at once with the shipping carrier or insuring agent as applicable.

At the request and expense of the Buyer, the Seller will render the Buyer every assistance in obtaining any documents which are issued in the country of delivery and/or of origin and which the Buyer may require for the purpose of exportation or importation and, where necessary, for their passage in transit through another country.

The Buyer will pay all costs and charges incurred in obtaining the documents mentioned in the preceding Clause and will also bear the cost of all other documents including Certificates of Origin, Export and Import Licenses and Consular fees and will further bear any customs duties and taxes that may be levied, whether by reason of exportation, importation or for any other cause.

SERVICE AND REPAIR INFORMATION

The Buyer must notify IRD Mechanalysis, Inc. in advance when returning products, for either normal or warranty covered repair. Product model and serial number should be included, along with details on the nature of the problem or service desired. Subsequent instructions will denote address of authorized service facility other than IRD Mechanalysis factory to which product should be shipped. When returning electronic products, all standard accessory equipment such as Pickups, Stroboscopic Light and Interconnecting Cables must be included to insure thorough checkout or repair calibration. Products and accessories should be packaged for shipment using conventionally acceptable methods.

Normal or warranty covered service or repair may be obtained at the Buyer's facility for products or installed systems which are impractical to ship. Charges for bona fide warranty service or repair will be limited to transportation and subsistance expenses for field representative. Additional charges reflecting current service or repair rates and cost of parts and materials may apply, in full or in part for cases when in the judgement of the representative full warranty coverage is not justifiable. These additional charges will be applicable in full for normal (non—warranty) service or repair.

TABLE OF CONTENTS

INTRODUCTION 1

DESCRIPTION. 2
Vibration Amplitude Meter. 2
Amplitude Range Switch 4
Access Door and SHUTDOWN INTERLOCK Switch. 4
SHUTDOWN RESET AND LEVEL ADJUST Switch and Adjustment. . . 4
WARNING and SHUTDOWN Lights and Relays 5
SYSTEM TEST Switch 6
ANALYZER Connector 6
Transient Time Delay 6
Startup Protection 6
Terminal Blocks and Cover Plate. 7
Model 544 Vibration Pickup 8
Pickup Cable 8
Optional System Components 8

SPECIFICATIONS 11
Model 1224 and 1225 Monitors 11
Model 544 Vibration Pickup 12
Standard Equipment Supplied with Monitor 14
Monitor Circuit Options. 14
Optional System Components 14

INSTALLATION 15
Monitor System Layout. 15
Component Mounting 16
Electrical Connections 20
Installation Checkout. 25

OPERATION. 29
Initial Testing. 29
Determining Warning and Shutdown Levels. 33
Setting Warning and Shutdown Levels. 36
Normal Operation 37
Incorrect System Test Readout. 39

CALIBRATION. 41
Amplitude Calibration. 41
Adjusting Test Signal Level. 45

LIST OF ILLUSTRATIONS

Figure 1. Model 1224 or 1225 Vibration Monitor and Accessories . . . . . Op. 1
Figure 2. Panel Details. 3
Figure 3. Terminal Blocks and Cover Plate. 7
Figure 4. Monitor Rear-Mounting Requirements 17
Figure 5. Monitor Panel-Mounting Requirements. 18
Figure 6. Pickup Mounting Techniques 19
Figure 7. 117- or 234-VAC Power Input Connections. 21
Figure 8. Vibration Signal Input and DC Recorder Connections 23
Figure 9. Connecting External Warning, Shutdown and Startup Protection Devices. 26
Figure 10. Cable Assembly Fabrication 27
Figure 11. General Machinery Vibration Severity Chart . . . 35
Figure 12. TIME DELAY Potentiometer Location. 38
Figure 13. Calibration Setup. 41
Figure 14. GAIN ADJUST Potentiometer Location 43
Figure 15. TEST SIGNAL ADJUST Potentiometer Location. . . . 44

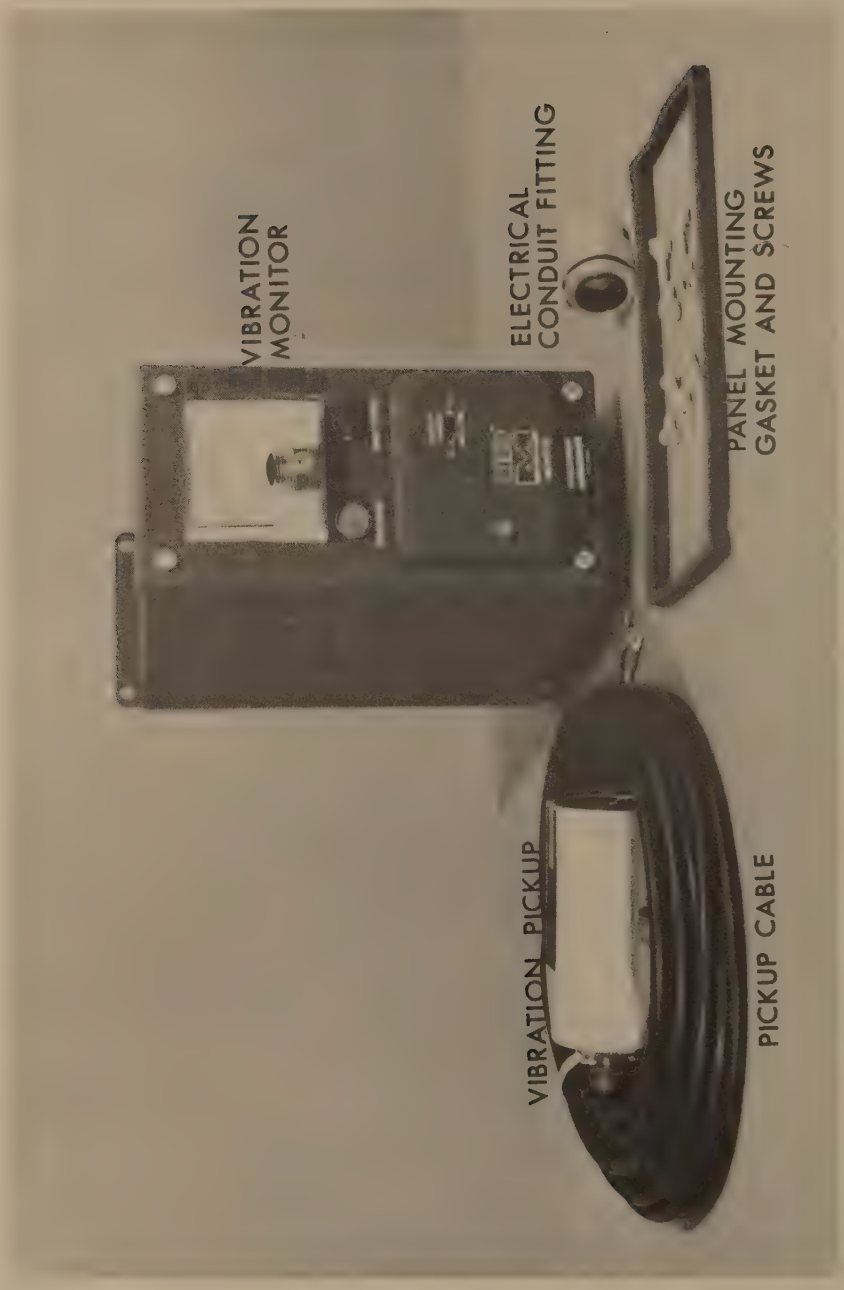


Figure 1. Model 1224 or 1225 Vibration Monitor and Accessories

INTRODUCTION

Machines in good operating condition will always produce some vibration. As mechanical trouble develops, a corresponding increase in vibration will occur. For many machines a controlled program of periodic vibration measurement is satisfactory for detecting developing trouble. Some machines, however, due to the critical nature of their operational or production role, require continuous monitoring of their mechanical condition. Unexpected failure of such machines typically would result in extensive repairs or would cause unduly large amounts of lost operating/production time, or both.

The Mechanalysis Model 1224 or 1225 Vibration Monitor, figure 1, provides two types of continuous and automatic protection for critical machinery. First, if mechanical trouble is developing gradually, the monitor can activate an audible warning device when the resulting increase in vibration reaches a preestablished level. Vibration analysis and other tests can then be performed to determine the exact nature of the problem, and shutdown and repairs scheduled for a convenient time. Secondly, when mechanical trouble develops rapidly to the point where extensive machine damage would occur with continued operation, the monitor can activate circuitry to immediately shut down the machine. In addition to these two protective features, the monitor provides a continuous visual readout of the vibration amplitude of the machine. This readout can provide an even further-advanced warning of developing trouble.

Monitor Models 1224 and 1225 are identical except for the vibration amplitude units in which they measure. This manual fully describes both models, and provides specifications and all of the installation, operation and calibration instructions necessary for proper utilization. It is recommended that the DESCRIPTION section of the manual be read carefully before proceeding with the remaining sections.

DESCRIPTION

Model 1224 and 1225 Vibration Monitors are identical with the exception that the Model 1224 measures vibration amplitude in displacement units, whereas the Model 1225 measures amplitude in velocity units. All information in the manual is applicable to both models unless stated otherwise.

The basic monitor "system" (figure 1) consists of the monitor unit and its companion vibration pickup and interconnecting cable. Customer-supplied warning and shutdown devices (actuated by the monitor) complete the basic system. This basic system can be expanded to include such features as increased number of vibration pickup points monitored, monitoring of equipment in hazardous areas, and continuous recording of vibration levels monitored. Components which provide these features are discussed in this section - refer to "Optional System Components."

The monitor is housed in a steel J.I.C.-approved case approximately 4-1/4 inches wide, 8-1/4 inches high and 8 inches deep suitable for mounting in or on a panel or wall. The case is gasketed to protect interior components from oil and dust. Two 1-1/16" diameter knockouts are provided for 3/4" I.D. thinwall electrical conduit fittings. A cover plate on the rear of the case provides access to the chassis terminal block where all external connections are made.

Mounting hardware and an electrical conduit fitting are included with the monitor. Major features are described in the remaining paragraphs of this section. Figure 2 illustrates the front panel features which are described.

VIBRATION AMPLITUDE METER

The Vibration Amplitude Meter provides a continuous indication of the peak-to-peak displacement in mils (Model 1224) or peak velocity in inches/second (Model 1225) as sensed by the vibration pickup mounted on the machine. The meter has two scales: 0 to 5 and 0 to 15. The scale in use corresponds to the position of the amplitude range switch visible through the window in the access door.

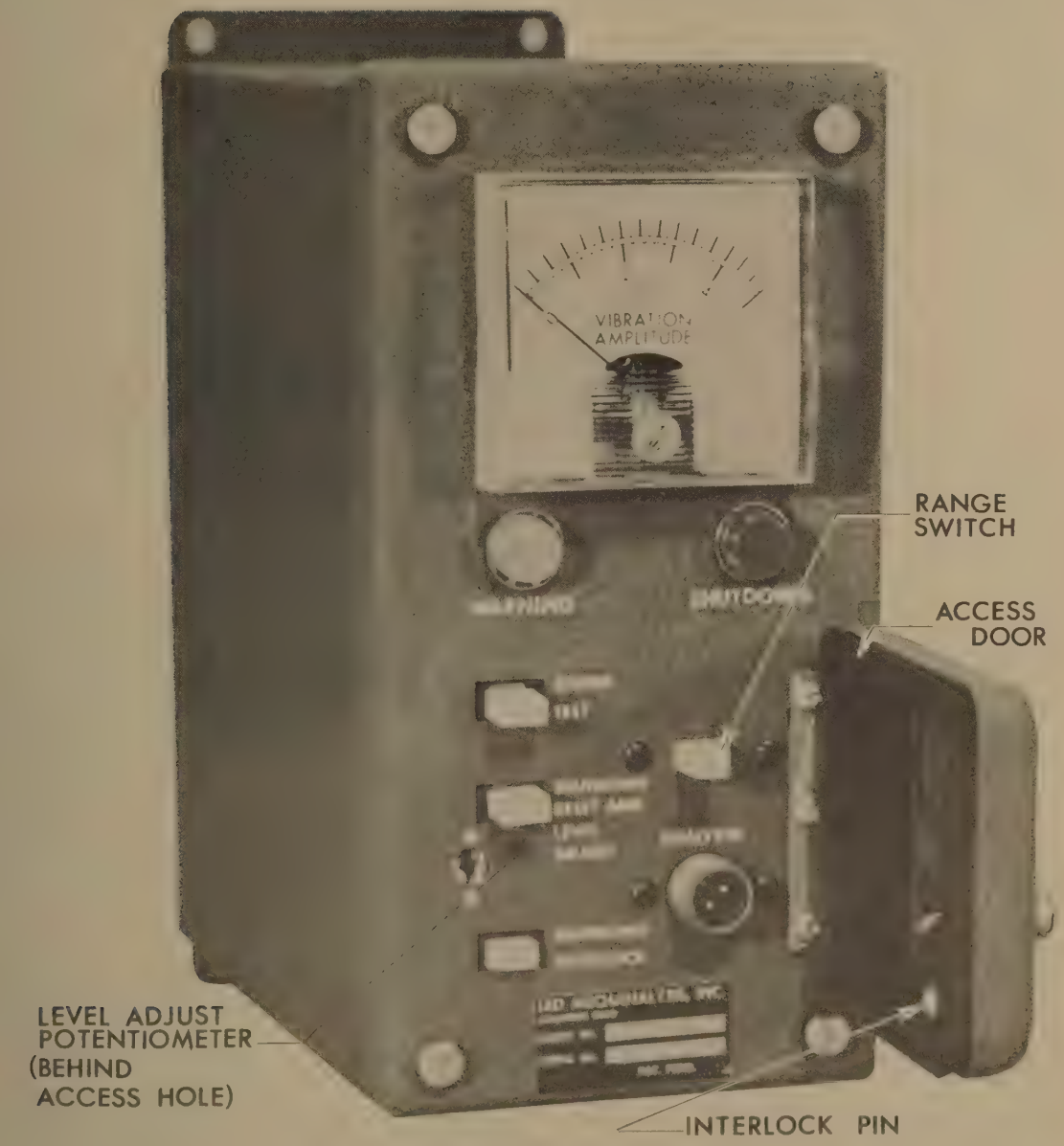


Figure 2. Panel Details

AMPLITUDE RANGE SWITCH

The Amplitude Range Switch is a two position slide switch that selects the meter scale used and determines the sensitivity of the monitor. In the left switch position a maximum vibration of 5 mils (Model 1224) or 0.5 in/sec. (Model 1225) can be monitored, and is read on the 0 to 5 meter scale. In the right position a maximum of 15 mils (Model 1224) or 1.5 in/sec. (Model 1225) can be monitored, and is read on the 0 to 15 meter scale. Positioning of the switch is visible through a window in the access door; ranges are marked adjacent to the window - see figure 1.

NOTE

Monitors supplied with meter scales in Metric units have the following ranges: Model 1224, displacement, 0 - 150 and 0 - 450 microns; Model 1225, velocity, 0 - 15 and 0 - 45 millimeters/sec.

ACCESS DOOR AND SHUTDOWN INTERLOCK SWITCH

The Access Door protects the monitor from oil and dust entry around switches and controls. This door also protects the monitor from tampering. The door is held closed with a quarter-turn latch. When the door is closed, the Interlock Pin on the door holds the SHUTDOWN INTERLOCK switch closed for normal circuit operation. When the door is open the switch is open to prevent an unwanted machine shutdown during monitor tests or adjustments.

CAUTION

When the access door is open no automatic shutdown of the machine being protected can occur. Keep the access door closed at all times except when working with the monitor controls.

SHUTDOWN RESET AND LEVEL ADJUST SWITCH AND ADJUSTMENT

The monitor is designed to actuate first a warning device (horn, annunciator, etc.) and then a shutdown device, as the level of the input vibration signal increases due to developing machine trouble. The points at which the warning and machine shutdown will occur are set with the SHUTDOWN RESET AND LEVEL ADJUST switch and the LEVEL ADJUST potentiometer located behind the access hole (figure 2). When the switch is depressed a "shutdown level" test

signal is internally applied to the vibration amplitude meter. The desired shutdown level, as read on the meter, is set by adjusting the potentiometer. This procedure also automatically sets the warning level, which is always two-thirds of the shutdown level, unless some other fractional value is specified at purchase. (External warning and shutdown devices will not be actuated during this process.)

When an automatic machine shutdown has been initiated by the monitor, momentarily depressing the SHUTDOWN RESET AND LEVEL ADJUST switch resets the monitor's shutdown circuitry for normal operation.

NOTE

> Although external shutdown control circuitry will be deactivated when the access door is opened (due to the interlock switch), the reset switch must still be depressed to restore normal circuit operation. If it is not, power to the protected machine cannot be reapplied, even when the access door is closed.

WARNING AND SHUTDOWN LIGHTS AND RELAYS

External warning and shutdown devices are actuated by two relays in the monitor. When the input vibration level reaches or exceeds the warning level (i.e., two-thirds of the shutdown level, set as previously described), the WARNING light and warning relay are simultaneously energized for a period of 10 seconds, and then de-energized. At this time, if the vibration level has dropped below the warning level the light and relay will remain "off;" if not, the 10-second "on" cycle will immediately begin again. The external warning device will operate in the same manner, being controlled by the warning relay.

If the vibration level continues to increase to the shutdown level, the SHUTDOWN light and shutdown relay are simultaneously energized, thus resulting in a shutdown of the machine being monitored (assuming a shutdown device is used). When the machine is shut down and the vibration then decreases below the warning level, the WARNING light and warning relay will remain "off" following completion of the most recent 10-second cycle. The shutdown relay will de-energize when the access door is opened; however, the SHUTDOWN light will remain on until the SHUTDOWN RESET AND LEVEL ADJUST switch is momentarily depressed. (The SHUTDOWN light must be out before power can be reapplied to the machine, if a shutdown

device is used with the monitor.)

The warning and shutdown relay contacts which control the external warning and shutdown devices are rated at 10 amperes resistive for 117-volt switching - see SPECIFICATIONS for complete rating details.

SYSTEM TEST SWITCH

When the SYSTEM TEST switch is depressed, an internally derived test signal "replaces" the normal vibration input signal. If the resulting amplitude meter reading falls within the green TEST area the signal processing circuitry, the pickup cable and the pickup are all in satisfactory condition. The warning and shutdown functions are also tested if their respective levels are reached or exceeded by the test signal level. However, if the shutdown level is reached no external shutdown will occur; the SHUTDOWN light will come on but the shutdown relay cannot operate with the access door open.

ANALYZER CONNECTOR

The ANALYZER connector on the front panel permits the monitor's pickup input signal to also be connected to the vibration input of any Mechanalysis Vibration Analyzer/Dynamic Balancer. This feature may be used for analyzing machine problems when a warning or shutdown condition has occurred, or for balancing the machine.

TRANSIENT TIME DELAY

A machine's vibration may momentarily exceed the "normal" level due to a variety of transient vibration conditions. An internal TIME DELAY adjustment in the monitor permits varied degrees of damping of these transient signals, to prevent unnecessary warning or shutdown sequences. The amount of time delay desired will vary with each machine.

STARTUP PROTECTION

Some machines produce a significantly higher-than-normal vibration level at some intermediate speed during startup. This higher level may exceed the monitor warning level, and possibly the shutdown level. In these cases, an external "Startup Protection" switch may be connected to the monitor. The switch is held "open" during machine startup, to prevent the warning sequence and to protect the machine from an undesirable shutdown sequence.

TERMINAL BLOCKS AND COVER PLATE

All external connections to the monitor are made at the terminal blocks on the rear of the chassis. See figure 3. The gasketed cover plate on the rear of the case provides access to the terminals, or the panel/chassis assembly may be removed for access.

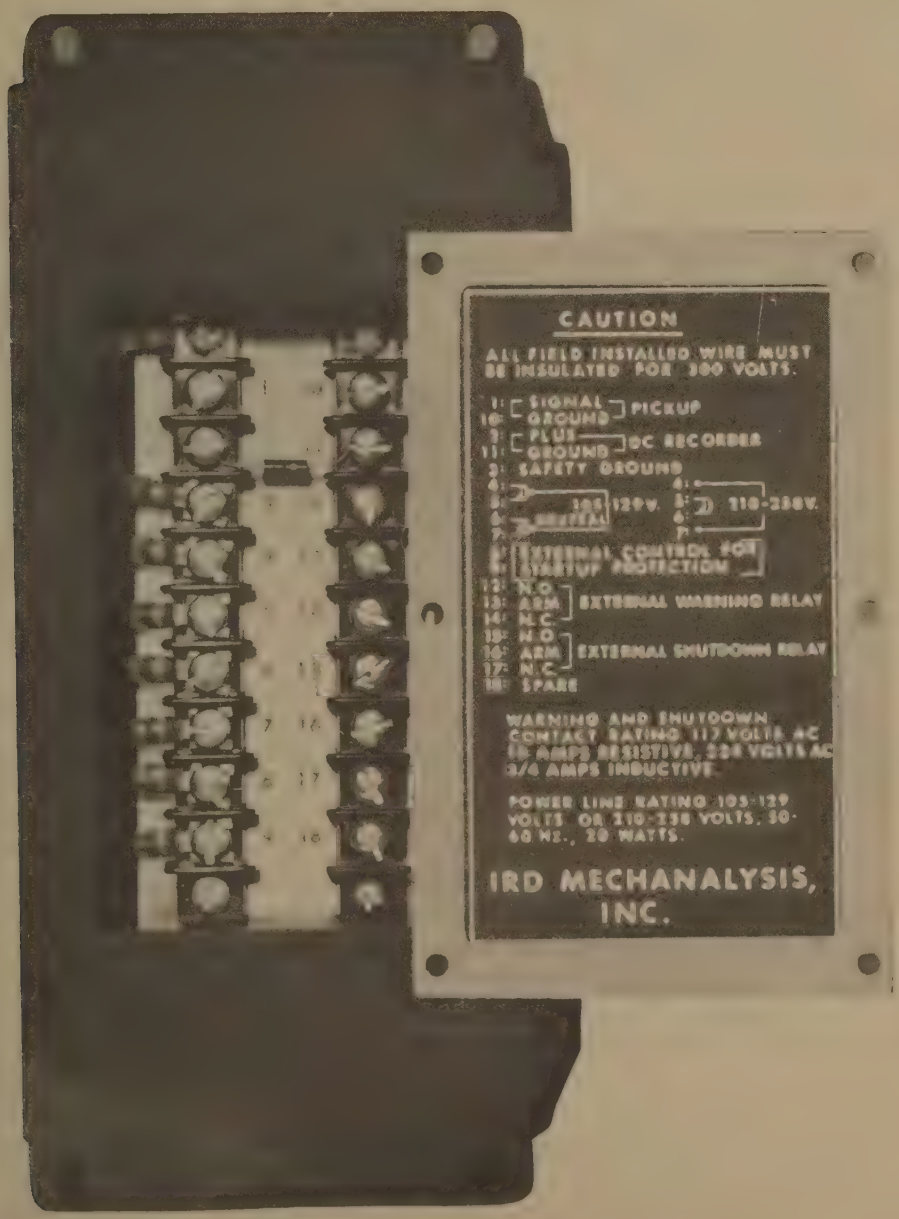


Figure 3. Terminal Blocks and Cover Plate

MODEL 544 VIBRATION PICKUP

The Model 544 Vibration Pickup is mounted directly on the machine bearing housing. Ideally, it is mounted with its long axis pointing at the centerline of the shaft. The pickup generates an output signal proportional to the vibration velocity existing where it is mounted. When the pickup signal is applied to the Model 1225 monitor the resulting readout is also in terms of vibration velocity (in inches/second). When the pickup signal is applied to the Model 1224 monitor, an integrating circuit "converts" the velocity-related signal to a displacement-related signal. The resulting readout is in displacement in mils (1 mil = 0.001 inch).

PICKUP CABLE

A 25-foot cable is provided for interconnecting the pickup and monitor. This "standard" cable can be used in temperatures up to 200° F. High-temperature cables are available for use up to 500° F. A total cable length of up to 750 feet, between the pickup and monitor, may be used. Complete details for fabricating longer cables are given in the INSTALLATION section. Details cover both standard (200° F) and high-temperature (500° F) cable fabrication.

OPTIONAL SYSTEM COMPONENTS

Components which may be used for expanding the basic monitor system are described in the following paragraphs.

Vibration Amplitude Recorder

The "DC RECORDER" terminals on the monitor are provided for connection of a vibration amplitude recorder. The output at these terminals is a d-c level proportional to the measured vibration amplitude. Connection requirements are given in the INSTALLATION section. The Mechanalysis Vibration Amplitude Recorder, Part No. 4922, is ideally suited for use with the monitor. Use of the recorder provides a permanent record of the vibration amplitude monitored over a continuous period of time. By periodically checking the recorder chart, changes from the "normal" vibration level can be readily observed. The recorder chart speed is one inch per hour; a standard chart roll permits continuous recording for one month.

Two-Channel and Four-Channel Scanners

The Mechanalysis Two-Channel or Four-Channel Scanner can be used with the monitor to increase the number of pickup points monitored. More points on a given machine may be monitored, or a single point on each of two to four machines may be monitored.

One Model 544 pickup is provided with the two-channel scanner. The scanner pickup and the pickup supplied with the monitor are connected to the two input channels of the scanner. The signal output of the scanner is connected to the vibration signal input of the monitor. A switch on the scanner provides for manual or automatic switching between the two pickup inputs. In the automatic ("SCAN") position one pickup is connected to the monitor for 40 seconds, and the other for 20 seconds. If a d-c recorder is used with the monitor, the vibration level associated with each pickup can be identified due to the difference in time that each level is recorded.

Three Model 544 pickups are provided with the four-channel scanner. The scanner pickups and the monitor pickup are connected to the four input channels of the scanner. The signal output of the scanner is connected to the vibration signal input of the monitor. A two-position switch controls the scanner. In the "SCAN" position the four input signal lines to the scanner are alternately connected to the signal output line (to the monitor) in one 60-second cycle. One channel is "on" for 24 seconds, and each remaining channel is on for 12 seconds, for channel identification on d-c recordings. A PICKUP indicator on the panel visually identifies which pickup is connected to the monitor at any given time. When the control switch is placed to the "DWELL" position, the automatic switching cycle is stopped; the PICKUP indicator/knob may then be manually rotated to a specific channel for continuous monitoring or analysis.

NOTE

> If a two- or four-channel scanner is used to provide monitoring of more than one machine, use of an external shutdown device (with the monitor) may not be practical.

Hazardous Area Enclosure

The Mechanalysis Hazardous Area Pickup Assembly, Part No. 4224, will permit monitoring of machines in NEC Class II, Division 1,

Groups E, F and D, and NEC Class I, Division I, Group D environments. The assembly consists of a Model 544 pickup sealed in an explosion-proof case. Installation requirements are supplied with the assembly. Only the Pickup Assembly can be located in the hazardous area.

Hazardous Area Intrinsically Safe Barrier

The Mechanalysis Safety Barrier, Part No. 7685, will permit monitoring of machines in NEC Class I, Division 1, Group B, C, and D environments. (Groups A, B, C and D in Canada.) The safety barrier makes the vibration pickup in the hazardous area "intrinsically safe." The barrier limits the amount of energy that can be transmitted to the pickup through the pickup cable, in the event of an electrical fault in the monitor (or scanner, if used). Only the pickup can be located in the hazardous area; the safety barrier and other monitor components must be located in a non-hazardous area. The safety barrier is approved by Factory Mutual Research Corporation and the Canadian Standards Association, for use with the Model 544 pickup, Model 1224 or 1225 monitor, and either the two-channel or four-channel scanner. Installation requirements are supplied with the barrier.

SPECIFICATIONS

MODEL 1224 AND 1225 MONITORS

Frequency Range:	300 to 150,000 CPM.
Amplitude Range:	Model 1224; English units, 0-5 and 0-15 mils full scale; Metric units, 0-150 and 0-450 microns full scale. Model 1225; English units, 0-0.5 and 0-1.5 in/sec. full scale; Metric units, 0-15 and 0-45 millimeters/sec. full scale.
Warning and Shutdown Levels:	Shutdown level is adjustable from 10% to 100% of full scale. Warning level is 2/3 of shutdown level. Other factory-set ratios available. Warning relay is automatically reset. Shutdown relay is manually reset.
Transient Vibration Time Delay:	Prevents warning or shutdown signals caused by short-duration transient vibrations. Adjustable internally from 3 to 10 seconds for damping of instantaneous signal increases from 30% to 110% of warning level.
Warning/Shutdown Relay Contact Ratings:	SPDT; 10A @ 117 VAC 60 Hz, resistive, or 3/4A @ 234 VAC 60 Hz, inductive. Contacts silver-cadmium oxide, gold plated.
DC Recorder Output:	Full scale d-c output (on either amplitude range) of 460 millivolts at 100 microamperes into a d-c impedance of 4600 ohms.
Power Requirements:	105-129 VAC, 50/60 Hz, 20 watts, or 210-258 VAC, 50/60 Hz, 20 watts.

Temperature Range:	Monitor Control Unit, 0° F. to 150° F. Vibration Pickup, -40° F. to 500° F.
Control Unit Connections:	Barrier terminal strips for connecting power, vibration pickup, DC recorder, warning and shutdown relay connections and external startup protection. A standard pickup cable connector is located on the front panel for a comparison check or for vibration analysis using a Mechanalysis vibration measuring or analyzing instrument.
Housing:	Steel, JIC-approved oiltight cabinet 4-1/4 x 8-1/4 x 8-1/4" with hinged gasketed door enclosing front panel controls, and gasketed rear cover plate for terminal strip access.

MODEL 544 VIBRATION PICKUP

The Model 544 Vibration Pickup is provided as standard equipment with all Mechanalysis vibration measurement, analysis and monitoring instruments. It is the most rugged and sensitive pickup of its type. Hand held or mounted on a machine it can be used in any position without affecting the readings. The pickup is a seismic velocity type consisting of a moving coil in a permanent magnetic field. The voltage output is directly proportional to the case velocity in the direction parallel to the pickup axis.

Sensitivity:	240 millivolts RMS ± 10% for 0.001 inch peak-to-peak displacement @ 100 Hz (6000 cpm) corresponding to a velocity constant of 1.08 volts peak per inch per second.
Orientation:	May be used in any mounting position without adjustment or correction.
Frequency Response:	Room ambient (± 77° F): ± 8% over the frequency range 12-1000 Hz; down 8% ± 13% @ 10 Hz; pickup frequency response drops exponentially at lower frequencies. Elevated am-

	bient (+ 250° F): ± 13% over the frequency range 12-1000 Hz. The above limits are total variations for any mounting position of the pickup.
Natural Resonant Frequency:	16 Hz critically damped at +77° F.
Temperature Range:	-40° F to 500° F.
Impedance:	2,000 (± 200) ohms DC resistance.
Maximum Allowable Vibration:	0.125 inches peak-to-peak displacement up to 70 Hz; 30 g's peak acceleration above 70 Hz.
Transverse Response:	Average response less than 5% over the frequency range 10-1000 Hz.
Amplitude Linearity:	± 5% from 0.0001 to 0.1000 inches peak-to-peak displacement.
Damping Characteristic:	The pickup has a damping factor of approximately 0.7 which results in essentially flat operation over the frequency range. This provides improved accuracy and improved transient response for low frequency operation.

Magnetic Field Sensitivity:

Without Shielding	0.15 in/sec/gauss
With 10:1Shield (Part No.1157)	0.015 in/sec/gauss
With 100:1 Shield (Part No.3563)	0.0015 in/sec/gauss

Power Required:	The pickup is a self-generating unit and requires no external power source.
Construction:	High-temperature solder connections. Case - machined aluminum. Pickup case and connector are watertight. Pickup performance is unaffected by

	humidity, condensation and immersion in water for short periods.
Mounting	One 1/4 - 28 x 1/4" tapped hole for mounting to suitable bracket and 1/4 - 28 stud.
Weight and Dimensions:	21 ounces. 4-7/8" long x 2-3/16" diameter.
Connector:	Equivalent to MS7328-10SL-4P.

STANDARD EQUIPMENT SUPPLIED WITH MONITOR

1 - Model 544 Vibration Pickup
1 - 25-foot Pickup Cable with Connectors (Part No. 8771)
1 - Set of Mounting Hardware
1 - Conduit Terminator
3 - Installation, Operation and Service Manuals

MONITOR CIRCUIT OPTIONS

Warning Level Option - Any fixed percentage of 50% to 90% of Shutdown Level is available. (Standard Warning Level is 67% of Shutdown Level.)

OPTIONAL SYSTEM COMPONENTS

Vibration Amplitude Recorder, Part No. 4922 *
Two-Channel Scanner, Part No. 5971 *
Four-Channel Scanner, Part No. 5837 *
Hazardous Area Pickup Assembly, Part No. 4224 *
Safety Barrier, Part No. 7685 #
Monitor Case, NEMA 3 Weather-Resistant Enclosure.
(Optional heater and thermostat available for NEMA 3 Case.)
Standard Bulk Pickup Cable, 750-ft. max. continous lengths, Part No. 4636. (Specify length with Part Number.)
High-Temperature Bulk Pickup Cable, 500-ft max. continuous lengths, Part No. 2832. (Specify length with Part Number.)
Standard Pickup Cable Connector, Part No. 4366. (Equivalent to MS3106E-10SL-4S(C).)
Vibration Pickup Accessories:
Magnetic Shield Assembly, 10:1 Shielding, Part No. 1157
Magnetic Shield Assembly, 100:1 Shielding, Part No. 3563
Pickup Insulator, Part No. 7441. (For use on machines which are electrically above ground potential.)

* Refer to DESCRIPTION section for details.

INSTALLATION

Installation of the monitoring system consists of four basic steps. These steps are covered in detail in this section, under the following headings:

Monitor System Layout

Component Mounting

Electrical Connections

Installation Checkout

MONITOR SYSTEM LAYOUT

List all of the components to be included in the system, including external warning, shutdown and startup protection devices. Make a sketch of the machine area, showing the proposed location of each component relative to the machine; include location of available a-c power sources. Finalize the sketch, considering the following recommendations or requirements;

1. Locate all components as near to machine, and as near to each other, as practical. Keep desirability of dirt- and moisture-free locations in mind.

2. Group components for operating convenience. If scanner is used, mount adjacent to monitor. If Startup Protection switch is used, locate near starting controls of machine.

3. Maximum allowable signal-path length, from pickup to monitor, is 750 feet using recommended cable. The total path includes routing through a scanner and/or intrinsic safety barrier, if used.

4. Use of electrical conduit is recommended for all pickup signal cable runs. If conduit is used, cable lengths must be measured accordingly. If conduit is not used, carefully choose routing for maximum signal cable protection; measure route chosen for correct cable length.

5. Use of electrical conduit is recommended for all power cable runs.

6. A switch or circuit breaker should be provided to control operating power to the monitor (and scanner, if included). Monitor power requirement is 20 watts. Scanner power requirement is 5 watts.

7. For Hazardous Area installations, only the pickup may be located in the hazardous area; all other components must be located in a "safe" area.

COMPONENT MOUNTING

Monitor Mounting

Figures 4 and 5 and their related notes provide all the necessary information required for either panel-mounting or rear-mounting the monitor. Mounting hardware is included with the monitor.

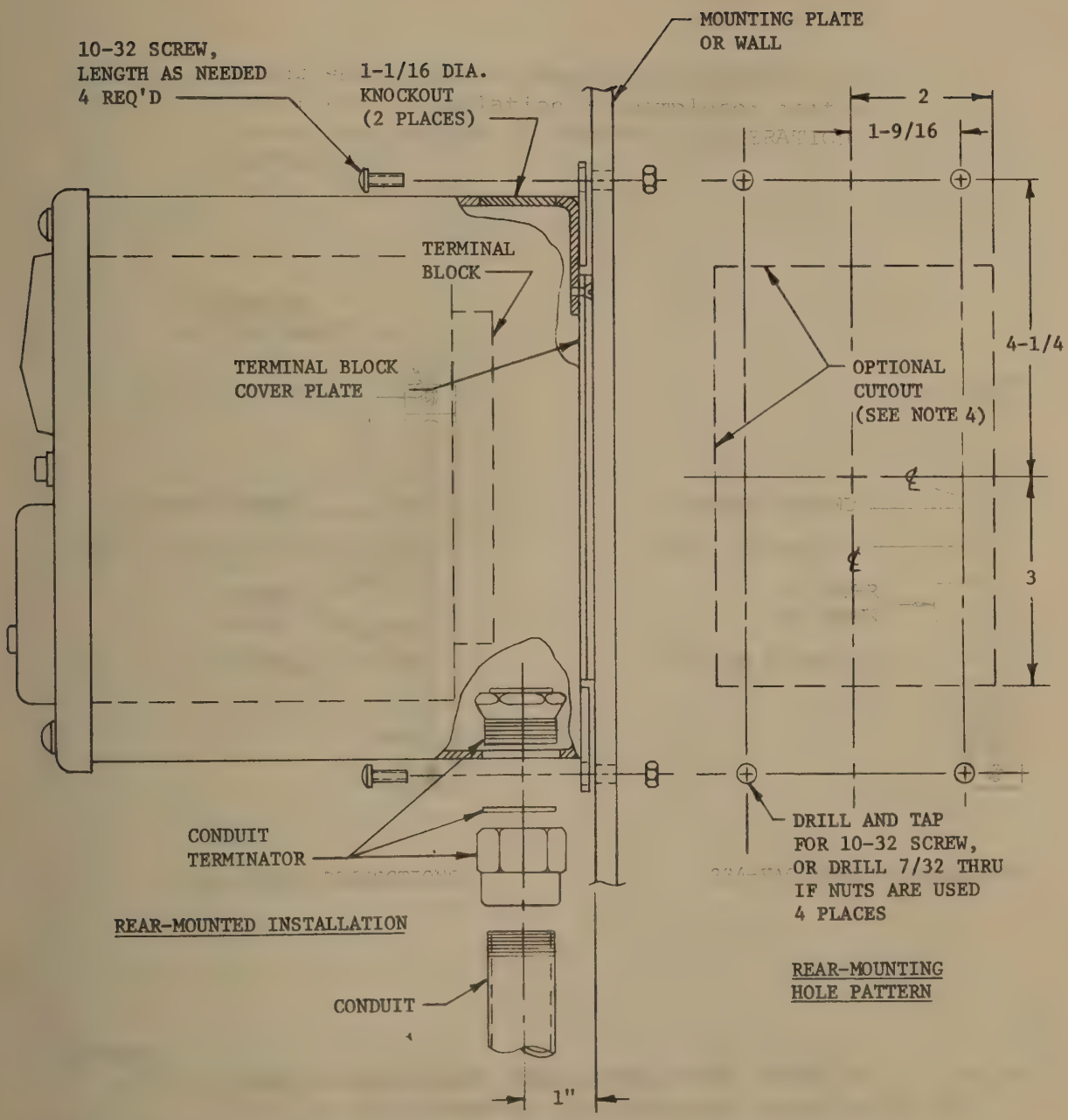
Vibration Pickup Mounting

The key to effective monitoring is a good pickup location. The most logical place is on a machine bearing housing. It is through the bearings of the machine that vibration forces are passed. Other points may be used so long as such a point is near a bearing, and has essentially the same vibration amplitude. The bearing or point selected should be one most likely to indicate developing trouble. Many manufacturers will recommend pickup locations for their machines upon request.

The use of a Mechanalysis Vibration Analyzer to make an analysis for selection of pickup locations is recommended. Using the analyzer to determine vibration frequency and amplitude will be helpful in choosing the pickup location, and in detecting any existing machine problems.

The Model 544 pickup has a 1/4-28 NF threaded hole 1/4-inch deep, in the end cap, for mounting. A 1/4-28 NF stud may be welded, brazed, or screwed to the machine for pickup installation; see figure 6. The stud end holding the pickup should be no longer than 1/4 inch, so that it will not bottom out in the end cap; the end cap or case perimeter should bear on the mounting surface. The surface on which the pickup bears should be smooth and flat. An alternate method using a mounting bracket may also be used, as suggested in figure 6. The bracket should be rugged, and have a very high resonant frequency, relative to the rotating frequency of the machine.

The pickup should be mounted so that its long axis is pointing toward the rotating shaft centerline. This provides maximum sensitivity to the machine's normal vibration, as well as vibration resulting from developing trouble.



NOTES:

1. ALL EXTERNAL WIRING TO REAR-MOUNTED MONITOR MUST HAVE STRANDED CONDUCTORS.
2. ALL EXTERNAL WIRING MUST HAVE INSULATION RATED AT 300 VOLTS.
3. ALLOW APPROXIMATELY 14 INCHES OF WIRING BETWEEN CONDUIT TERMINATOR AND TERMINAL BLOCK TO PERMIT REMOVAL OF CHASSIS FROM CASE.
4. IF ACCESS TO REAR OF WALL OR MOUNTING PLATE IS AVAILABLE, OPTIONAL 4 X 6" CUTOUT AS SHOWN WILL PERMIT REMOVAL OF TERMINAL BLOCK COVER PLATE.

Figure 4. Monitor Rear-Mounting Requirements

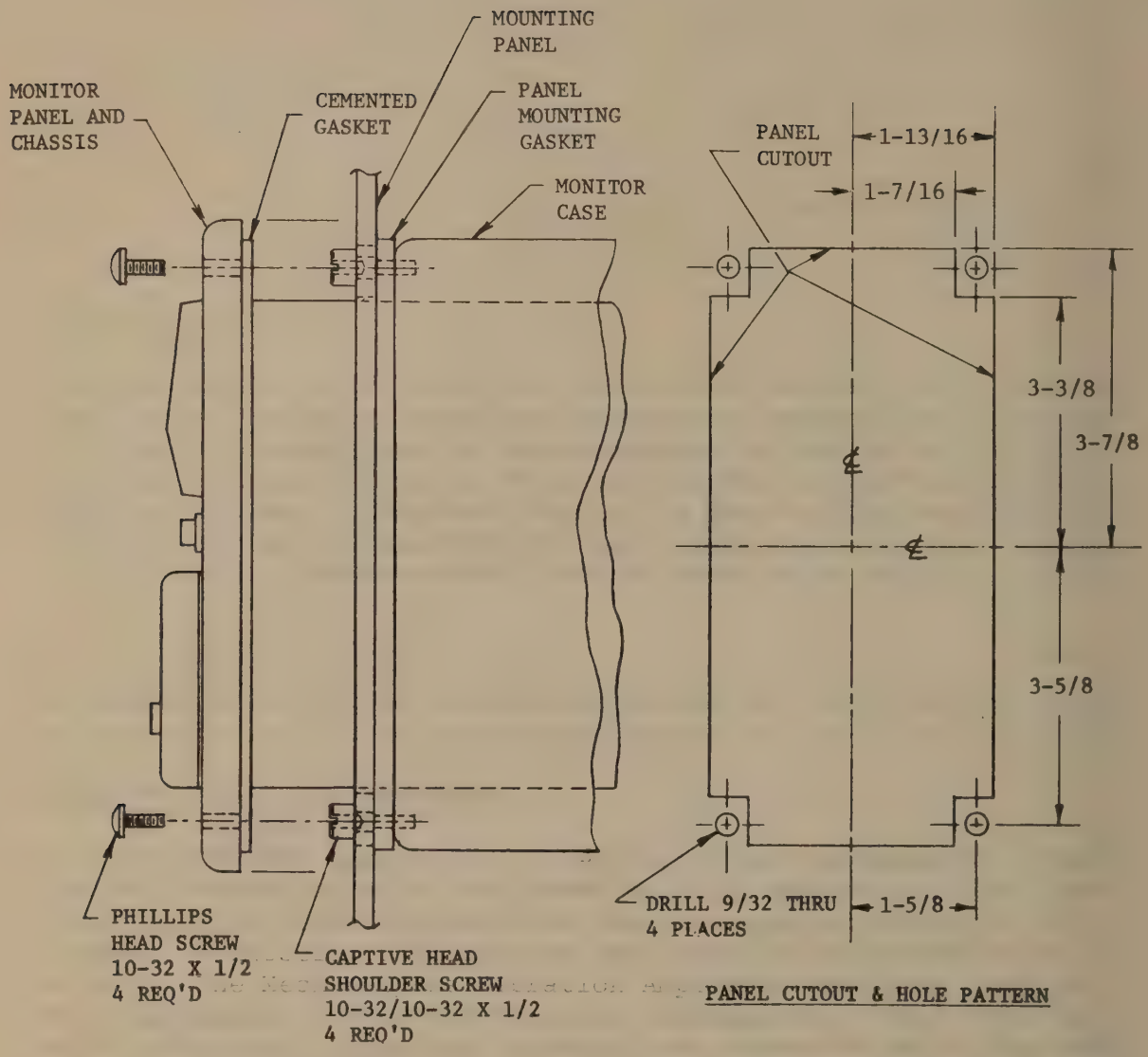


Figure 5. Monitor Panel-Mounting Requirements

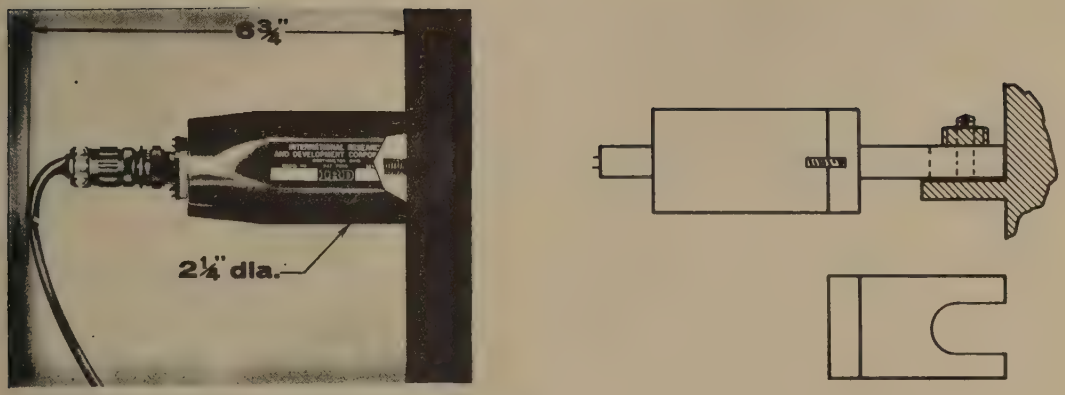


Figure 6. Pickup Mounting Techniques

All of the previous information applies equally for pickup installations in hazardous areas. However, if the Hazardous Area Pickup Assembly (Part No. 4224) is used, a flat mounting surface approximately 5-3/4 inches square is required. A free 8-3/4-inch-high area above the mounting surface is required to accept the assembly. Four 1/4-inch diameter bolts on a 4-1/2-inch square hole pattern are required for mounting; detailed instructions are included with the assembly.

Intrinsic Safety Barrier Mounting

If the intrinsic safety barrier (Part No. 7685) is used with the pickup, the barrier must be located outside the hazardous area, and should be placed where it cannot be damaged. Use of a NEMA-1 switch box or the equivalent is recommended as an enclosure. Detailed installation instructions are provided with the barrier.

Two-Channel or Four-Channel Scanner Mounting

Mounting requirements for either of the scanners, if used, are the same as for the monitor. Case dimensions, conduit knockouts, and mounting hole and cutout patterns are identical. The same mounting hardware is supplied. Instructions are included with the scanner.

DC Recorder Installation

A DC recorder, if used, should be located near the monitor. Mount the recorder as instructed by the manufacturer.

Mounting External Warning, Shutdown and Startup Protection Devices

Choice of devices and mounting technique are left to the user. Basic considerations are as follows:

1. Current requirements for warning and shutdown devices should be within the limits given for the warning and shutdown relay contacts; see SPECIFICATIONS section.

2. The Startup Protection switch should be a spring-loaded, "momentary-off" toggle or pushbutton type. A 117-volt 3/4 ampere rating is sufficient. (Existing machine startup controls may be adaptable for opening the startup protection circuit automatically, during the startup sequence.)

ELECTRICAL CONNECTIONS

Use of thinwall electrical conduit is recommended for routing all wiring to and from the monitor. Two knockouts are provided for conduit-terminating fittings; see figure 4. (One terminator is provided.) Instructions for power, signal, and control device connections are given as follows:

NOTE

All external wiring to the monitor must have insulation rated at 300 volts or more. If monitor is rear-mounted, all wiring must have stranded conductors.

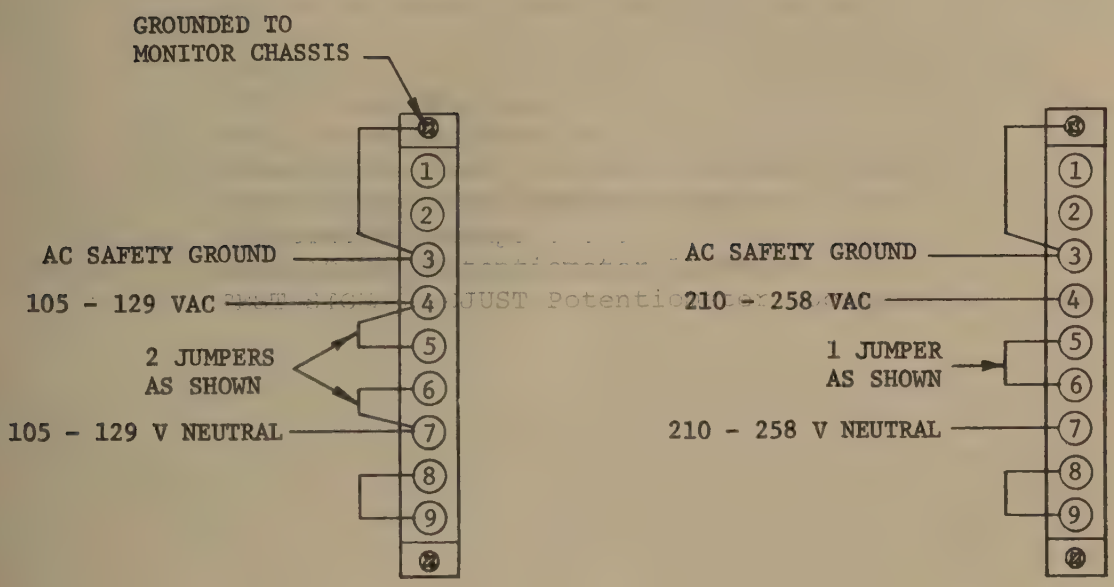
117- or 234-VAC Power Input Connections

The monitor may be connected to either a 117- or 234-volt 50/60 Hz power source. Input connections and jumper arrangements for either case are shown in figure 7. Observe instructions given in the notes with the illustration.

NOTE

An external switch or circuit breaker should be provided for controlling operating power to the monitor. Nominal power requirement is 20 watts.

Power should not be applied to the monitor until the installation is complete; initial power application is covered in OPERATION section.



117-VAC INPUT CONNECTIONS

234-VAC INPUT CONNECTIONS

NOTES:

1. ALL EXTERNAL WIRING MUST HAVE INSULATION RATED AT 300 VOLTS.
2. IF MONITOR IS REAR-MOUNTED, ALL EXTERNAL WIRING MUST HAVE STRANDED CONDUCTORS.
3. ALLOW APPROXIMATELY 14 INCHES OF WIRING BETWEEN CONDUIT TERMINATOR AND TERMINAL BLOCK FOR WIRING CONNECTIONS.

Figure 7. 117- or 234-VAC Power Input Connections

Vibration Signal Input and DC Recorder Connections

The vibration signal input terminals of the monitor will be connected to one of four components, as indicated in figure 8, depending on the specific monitoring system. Observe instructions given in the notes with the illustration. (For systems using a scanner and/or safety barrier, refer to wiring instructions included with the components to complete the signal path.) Use the 25-foot cable supplied, if long enough, for connecting the pickup to the appropriate system component (safety barrier, scanner or monitor). If longer or additional signal cables are needed, fabricate as described in "Cable Assembly Fabrication," page 24.

CAUTION

> The 4700-ohm resistor across terminals 2 and 11 is to be connected at all times when a DC recorder is NOT connected to those terminals; if it is not, erroneous amplitude readings will result.

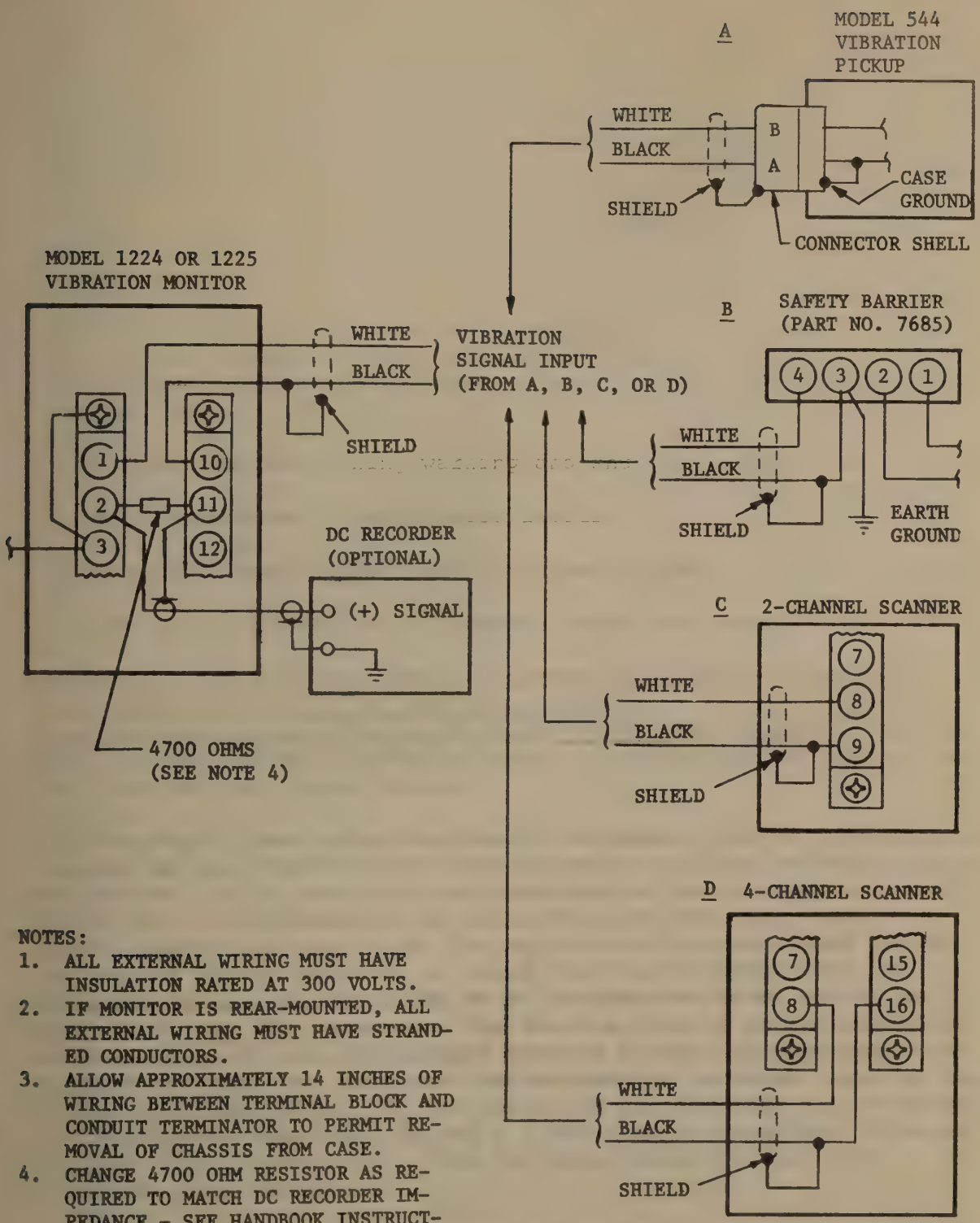
DC recorder connections are shown in figure 8. Use of coaxial cable is recommended. The full-scale d-c output (for either amplitude range) is 460 millivolts at 100 microamperes, into a d-c impedance of 4600 ohms. Impedance matching requirements for the recorder to be used are as follows:

NOTE

> Impedance matching errors will result in monitor amplitude-meter reading errors.

1. For high-sensitivity recorders with a d-c impedance of less than 4400 ohms, remove 4700-ohm resistor from terminals 2 and 11. Add series resistance in recorder signal line so that the total load across terminals 2 and 11 is 4600 (± 230) ohms. (If the full-scale current limit of the recorder is less than 100 microamperes, a shunt may also be added across the recorder input. However, the total series-parallel load must still be as previously stated.)

2. The d-c impedance of the Vibration Amplitude Recorder, Part No. 4922, is 4600 ohms. When connecting this recorder, or recorders with a d-c impedance of 4400 to 4800 ohms, remove the factory-installed 4700-ohm resistor from terminals 2 and 11.



NOTES:

1. ALL EXTERNAL WIRING MUST HAVE INSULATION RATED AT 300 VOLTS.
2. IF MONITOR IS REAR-MOUNTED, ALL EXTERNAL WIRING MUST HAVE STRANDED CONDUCTORS.
3. ALLOW APPROXIMATELY 14 INCHES OF WIRING BETWEEN TERMINAL BLOCK AND CONDUIT TERMINATOR TO PERMIT REMOVAL OF CHASSIS FROM CASE.
4. CHANGE 4700 OHM RESISTOR AS REQUIRED TO MATCH DC RECORDER IMPEDANCE - SEE HANDBOOK INSTRUCTIONS.

Figure 8. Vibration Signal Input and DC Recorder Connections

3. For recorders with a d-c impedance (Z_r) of more than 4800 ohms but less than 100K ohms, remove 4700-ohm resistor and connect impedance matching resistor (Z_m) across terminals 2 and 11; determine value of Z_m as follows; the actual value used may vary ± 5% from the calculated value:

$$Z_m = \frac{4600\ Z_r}{Z_r - 4600} \text{ (ohms)}$$

4. For recorders with a d-c impedance of 100K ohms or higher, the 4700-ohm resistor should be connected across terminals 2 and 11.

Connecting External Warning, Shutdown and Startup Protection Devices

Figure 9 shows a simplified schematic of the monitor warning and shutdown relays and control circuitry. A possible arrangement of external warning, shutdown and startup protection devices is also shown. Actual devices and circuitry are left to the judgement of the user; however, the instructions included with figure 9 should be observed.

The shutdown relay cannot operate unless the 117-volt warning relay is energized. Opening the normally-closed Startup Protection switch during machine startup thus prevents both the warning and shutdown sequences from occuring. Whether or not this switch must be used will depend on the vibration levels produced by the machine during startup. If the switch is required, it should be rated for 117-volt 3/4-ampere use.

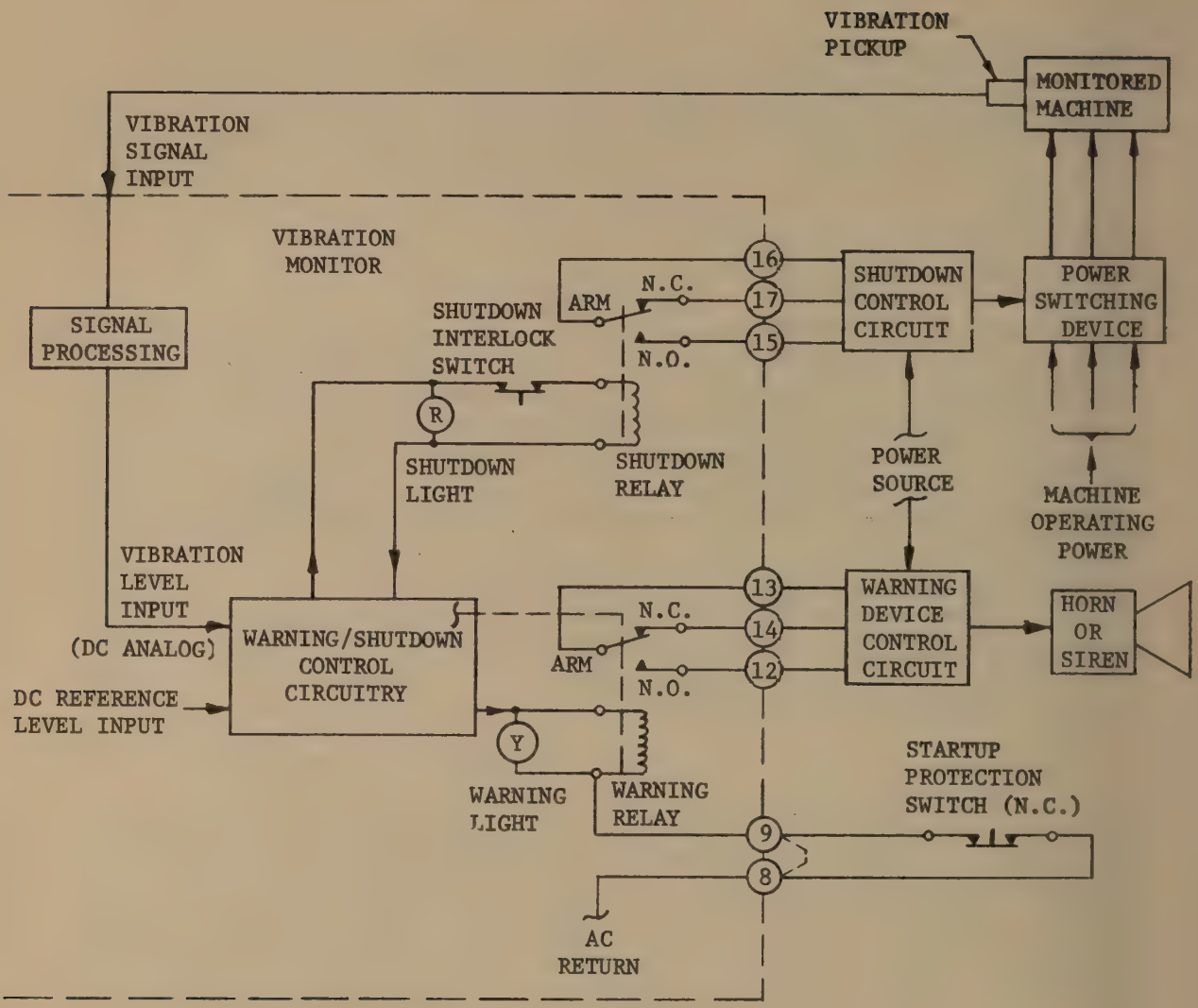
Cable Assembly Fabrication

Fabrication details for pickup signal cable assemblies are shown in figure 10. Sheet 1 shows fabrication requirements for adding a pickup connector. Sheet 2 shows requirements for adding terminal lugs. Assemblies for connecting pickups to other components (monitor, scanner, or safety barrier) require a standard pickup connector on one end and terminal lugs on the other. Assemblies for connecting safety barrier to scanner, safety barrier to monitor, or scanner to monitor, require terminal lugs on both ends. Instructions are provided for using either standard (200° F) cable or high-temperature (500° F) cable. Refer to SPECIFICATIONS section for cable and connector part numbers, if these materials are to be ordered from IRD Mechanalysis, Inc. Beldon 8428, 18-gauge two-conductor shielded cable, or the equivalent, may be used for

standard assemblies. CIMCO H20-1932, 20 gauge single-conductor shielded cable, or the equivalent, may be used for high-temperature assemblies. When determining cable lengths required, allow for extra length required to permit removal of chassis of monitor (or scanner). For high-temperature assemblies, be sure to use high-temperature rosin-core solder.

INSTALLATION CHECKOUT

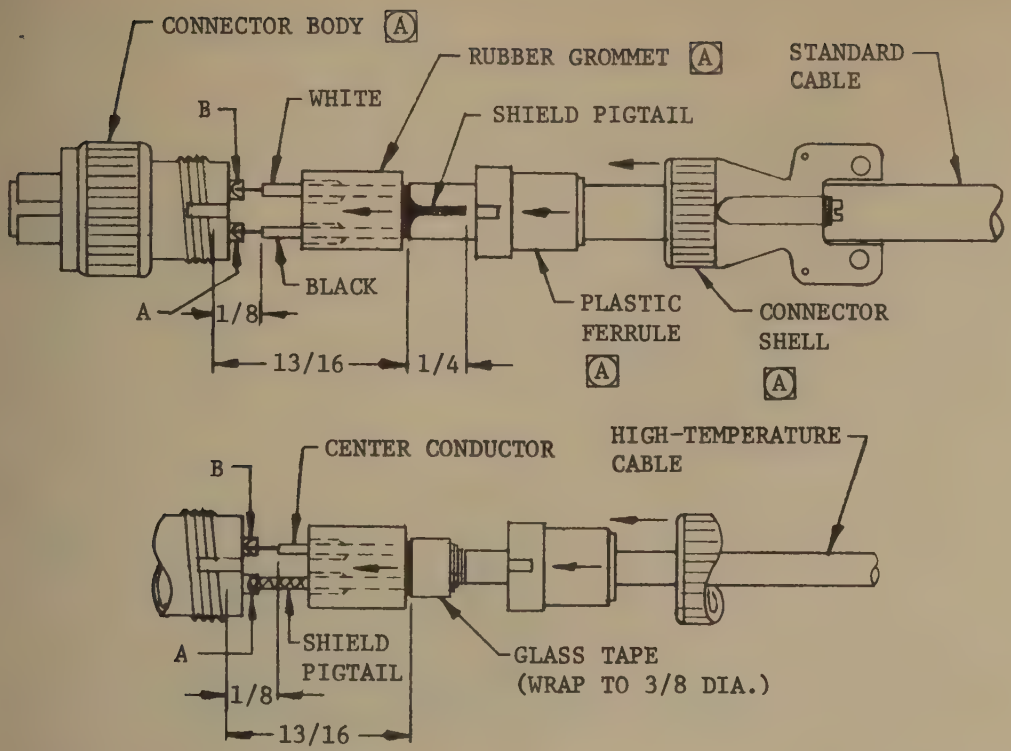
Check out the installation to ensure that all requirements have been met. Review the mounting and electrical connection instructions. Check all components and enclosures to be securely mounted. Check all wiring for routing to proper terminals, and check all connections to be mechanically tight. Use of an ohmmeter and voltmeter for checking out wiring is recommended. Functional checkout of the system will be accomplished in the OPERATION section.



NOTES:

1. SHUTDOWN INTERLOCK SWITCH IS HELD IN POSITION SHOWN WHEN MONITOR ACCESS DOOR IS CLOSED.
2. JUMPER BETWEEN TERMINALS 8 AND 9 IS REMOVED ONLY IF NORMALLY-CLOSED STARTUP PROTECTION SWITCH IS INSTALLED.
3. REFER TO "SPECIFICATIONS" FOR WARNING/SHUTDOWN RELAY CONTACT RATINGS.
4. ALL EQUIPMENT SHOWN EXTERNAL TO MONITOR (EXCEPT PICKUP) IS SUPPLIED BY USER.
5. ALL EXTERNAL WIRING MUST HAVE INSULATION RATED AT 300 VOLTS.
6. IF MONITOR IS REAR-MOUNTED, ALL EXTERNAL WIRING MUST HAVE STRANDED CONDUCTORS.
7. ALLOW APPROXIMATELY 14 INCHES OF WIRING BETWEEN TERMINAL BLOCK AND CONDUIT TERMINATOR TO PERMIT REMOVAL OF CHASSIS FROM CASE.

Figure 9. Connecting External Warning, Shutdown and Startup Protection Devices



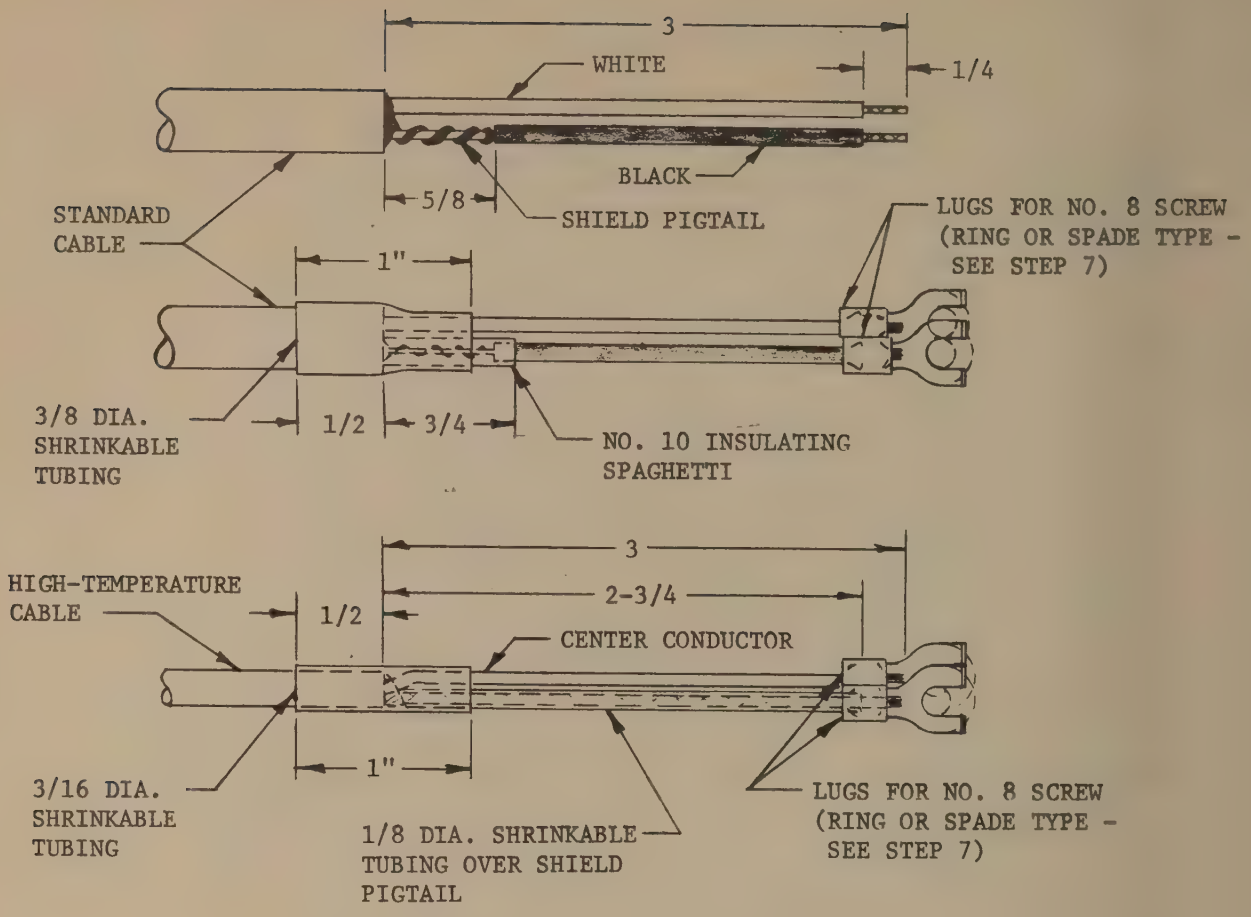
ASSEMBLY INSTRUCTIONS

(A) PART OF CONNECTOR ASSEMBLY

STANDARD CABLE	HIGH-TEMPERATURE CABLE	
1	1	REMOVE CABLE CLAMPS FROM CONNECTOR SHELL.
2	2	SLIDE CONNECTOR SHELL AND PLASTIC FERRULE ON CABLE.
3	3	REMOVE 13/16" OUTER INSULATION TO EXPOSE BRAIDED SHIELD.
4	4	UNRAVEL SHIELD, TWIST INTO PIGTAIL, AND TIN LIGHTLY.*
5	5	REMOVE 13/16" INSULATION TO EXPOSE INSULATED CONDUCTOR(S).
6		TRIM PIGTAIL TO 1/4" AND FOLD BACK AGAINST CABLE.
	6	CUT PIGTAIL TO 13/16" LENGTH. BUILD UP CABLE DIAMETER TO 3/8" IN AREA SHOWN, WITH GLASS ADHESIVE TAPE.
7	7	STRIP 1/8" INSULATION FROM END OF LEAD(S), AND TIN.*
8	8	INSERT LEADS IN RUBBER GROMMET (LARGE HOLES OF GROMMET TOWARD CONNECTOR BODY). PUSH GROMMET TOWARD FERRULE.
9	9	SOLDER LEADS TO CONNECTOR PINS.*
10	10	COAT SOLDER CONNECTIONS WITH SILICONE COMPOUND. PUSH GROMMET UP FLUSH WITH REAR OF CONNECTOR BODY. COAT GROMMET AND EXPOSED LEADS LIBERALLY WITH SILICONE COMPOUND, THEN SLIDE FERRULE OVER GROMMET. (ALIGN FERRULE KEY WITH CONNECTOR KEYWAY.)
11	11	COAT CONNECTOR THREADS WITH LOCTITE GRADE B, OR EQUIVALENT. SLIDE CONNECTOR SHELL OVER FERRULE AND THREAD ONTO CONNECTOR. TIGHTEN FIRMLY.
12		INSTALL CABLE CLAMPS - POSITION PIGTAIL SO THAT CLAMP WILL HOLD IT FIRMLY, AND TIGHTEN CLAMP SCREWS.
	12	INSTALL CABLE CLAMPS OVER TAPE AND TIGHTEN CLAMP SCREWS.

* USE 60/40 FLUX-WIRE OR HIGH-TEMPERATURE ROSIN CORE SOLDER, AS APPROPRIATE

Figure 10. Cable Assembly Fabrication (Sheet 1)



ASSEMBLY INSTRUCTIONS

STANDARD CABLE	HIGH-TEMPERATURE CABLE	
1	1	REMOVE 3" OUTER INSULATION. UNRAVEL SHIELD AND TWIST INTO PIGTAIL.
2	2	REMOVE 3" INSULATION TO EXPOSE INSULATED CONDUCTOR(S). STRIP 1/4" INSULATION FROM END OF LEAD(S).
3		TRIM 5/8" INSULATION FROM BLACK LEAD IN AREA SHOWN.
4		WRAP SHIELD PIGTAIL AS SHOWN AND SOLDER WITH 60/40 FLUX-WIRE SOLDER.
5		ADD 3/4" LENGTH OF NO. 10 INSULATING SPAGHETTI AS SHOWN.
	3	CUT PIGTAIL TO 3" LENGTH AND TIN LIGHTLY WITH HIGH-TEMPERATURE SOLDER.
	4	COVER PIGTAIL WITH 2-3/4" LENGTH OF 1/8" DIA. SHRINKABLE TUBING.
	5	SHRINK TUBING ON PIGTAIL WITH HEAT.
6	6	ADD 1" LENGTH OF (3/8 OR 3/16" DIA.) SHRINKABLE TUBING AS SHOWN AND SHRINK WITH HEAT.
7	7	RING TYPE LUGS MUST BE USED FOR CONNECTION TO INTRINSICALLY SAFE BARRIER. LUG TYPE IS OPTIONAL FOR CONNECTION TO MONITOR OR SCANNER. CRIMP ON APPROPRIATE LUGS.

Figure 10. Cable Assembly Fabrication (Sheet 2)

OPERATION

This section covers initial testing following installation of the system, determining and setting the proper warning and shutdown levels, and normal operating requirements. A procedure is also included for troubleshooting the system, when self-test results are not satisfactory.

INITIAL TESTING

This test should be performed with the monitored machine(s) running. A small straight-bladed screwdriver is required for adjusting the LEVEL ADJUST potentiometer, which is reached through the access hole on the front panel - see figure 2.

1. Open monitor access door. Set amplitude range switch to the high range (slide to right). Using screwdriver, turn LEVEL ADJUST potentiometer CW approximately 15 turns. Leave access door open.

2. If scanner is installed, set scanner selector switch to "SCAN" position.

3. Close switch or circuit breaker controlling operating power to monitor (and scanner, if installed). A reading should be present on the amplitude meter. (A warning sequence should not occur at this time. If it does, check amplitude meter reading. If reading is less than 2/3 of full scale, turn LEVEL ADJUST CW until warning stops. If reading is 2/3 full scale or higher, vibration is too excessive for the monitor warning function to be used until vibration level is reduced.)

4. Observe amplitude meter reading for at least 60 seconds. (If a scanner is installed, the reading will change value as the different pickup inputs are alternately connected to the monitor.) If the largest steady reading observed is less than 10% of full scale, set amplitude range switch to the low range (slide to left).

5. Record the highest steady amplitude reading observed in a 60-second interval.

6. Depress the SYSTEM TEST pushbutton, and confirm an amplitude meter reading within the green TEST area. If a scanner is installed, hold the test switch in and observe meter for at least 60 seconds (complete scan cycle) so that all pickups and their cables are checked by the test. The meter reading may change

slightly, but should remain within the TEST area during the complete scanning cycle. Release test switch.

NOTE

Ideally, the SYSTEM TEST reading will be very near exact center scale. If a safety barrier is installed, a slightly higher reading can be expected, but should still be within the TEST area. If a d-c recorder is installed, a poor impedance match can produce a slightly high or low readout within the TEST area, or a totally incorrect readout; refer to step 15. Refer to "INCORRECT SYSTEM TEST READOUT" in this section for other causes of readout errors.

7. If scanner is installed, manually set the scanner for continuous monitoring of the channel which produces the highest amplitude meter reading - refer to step 5.

8. Slowly turn LEVEL ADJUST potentiometer CCW until WARNING light and warning device operate, then depress SHUTDOWN RESET AND LEVEL ADJUST and note meter reading. Release switch and turn potentiometer at least one full turn CW. Warning sequence should end in 10 to 15 seconds. Meter reading noted should be approximately 1.5 times the value recorded for step 5.

NOTE

Steps 9 through 11 check out the shutdown sequence. Perform step 9, then either step 10 or step 11 as applicable. Step 10 is performed if an external shutdown device is not installed; step 11 is performed if device is installed.

9. Turn LEVEL ADJUST CCW to the point where the SHUTDOWN light comes on.

10. (NO SHUTDOWN DEVICE INSTALLED.) Turn off power to machine. Warning sequence should end as machine coasts down. SHUTDOWN light will remain on. Proceed to step 12.

11. (SHUTDOWN DEVICE INSTALLED.) Close the access door firmly and lock with screwdriver; machine shutdown should begin. Warning sequence will end as machine coasts down. During coastdown, turn

off machine's main power switch.

12. Open access door, if closed. Depress and hold SHUTDOWN RESET AND LEVEL ADJUST. Confirm that SHUTDOWN light goes out, and turn LEVEL ADJUST potentiometer CW as required to obtain a "shutdown level" (meter reading) of full scale or 3 times the value recorded for step 5, whichever is less. Release the level adjust switch. (This step provides a temporary setting of the warning and shutdown levels.)

NOTE

Warning sequence may occur during next step and SHUTDOWN light may come on.

13. With access door open, start up the machine, carefully observing the maximum meter reading which occurs up to the time the machine reaches normal operating speed. Record the maximum value in pencil:_____. (Knowing this value will help determine whether the Startup Protection switch must normally be used during machine startup, after warning and shutdown levels are finalized.)

14. If the SHUTDOWN light is on, momentarily depress SHUTDOWN RESET AND LEVEL ADJUST pushbutton - the light should go out.

15. If a d-c recorder is installed, and special impedance matching was required, the accuracy of the matched load may be checked as follows:

a. Depress SYSTEM TEST switch and record the exact amplitude meter reading as measured on upper scale.

b. Turn off power to monitor. Disconnect recorder and impedance-matching resistor(s) from terminals 2 and 11.

c. Connect 4700-ohm resistor across terminals 2 and 11.

d. Reapply power, and depress SYSTEM TEST. The meter reading obtained in step a should be within ± 5% of the exact TEST value observed in this step. If it is not,accurately read and record present TEST value, from upper scale.

e. Turn off monitor power. Remove 4700-ohm resistor. Reconnect recorder. If necessary, change value of matching resistor(s) as needed to obtain TEST value within ± 5% of value noted in step d.

NOTE

In some installations, the monitored machine may be electrically "above ground". That is, there may be some voltage on the machine frame, with reference to earth ground. This condition can cause a current flow in the pickup cable, resulting in erroneous vibration readings. The remaining steps provide a check for this condition, and some possible remedies if needed.

16. Remove the pickup from the machine. (If scanner is installed, make sure that appropriate channel is manually selected.) Hold the pickup end cap firmly against the machine, near the normal mounting position, and carefully note exact meter reading on monitor.

17. Place a thin piece of insulating material (paper, plastic film, etc.) between pickup and machine and hold pickup in position as before. (Do not use insulating material which would tend to dampen vibration.) Carefully note exact meter reading.

18. Repeat steps 16 and 17 several times. The average reading obtained for step 16 should be within 2 or 3 percent of the average reading for step 17. If not, one or more of the following remedies may be used.

a. Connect the machine case to a good earth ground, as near as possible to the machine, using No. 10 AWG (or larger) solid copper wire. Repeat steps 16 through 18.

b. Isolate the Model 544 pickup from the machine with Pickup Insulator, Mechanalysis Part No. 7441. (Overall insulator dimensions are 2-1/4" dia. by 1/2" thick. Mating surface on machine must be flat. Mounting requirements are four 1/4-28 cap screws on 1-1/2" dia. circle, spaced 90° apart.)

c. Turn off power to monitor and disconnect a-c safety ground lug from terminal 3. Remove green jumper connected between terminal 3 and the upper left Phillips-head terminal block mounting screw. Install a-c safety ground lug under the Phillips-head screw and tighten firmly. (Pickup signal ground is now isolated from chassis ground.) Turn on monitor power and repeat steps 16 through 18.

DETERMINING WARNING AND SHUTDOWN LEVELS

Several methods may be used for determining the warning and shutdown levels to be set up on the monitor. Before arriving at a fixed value, however, a vibration analysis of the machine(s) to be monitored should be performed if a Mechanalysis Vibration Analyzer is available. Analysis will accurately define the condition of the machine; any troubles detected may then be corrected. Warning and shutdown levels can then be altered accordingly. If the machine is in very good condition the levels can be set slighly higher, or vice-versa. Analysis will also define specific vibration characteristics. For example, if high-frequency vibration is significant, warning and shutdown levels might be set slightly lower than for a "general" case.

The methods for determining warning and shutdown levels are:

Use manufacturer's recommended levels

Determine levels from Vibration Severity Chart

Base levels on machine's "normal" vibration level

The warning and shutdown levels recommended by the machine manufacturer should always be used when available. If not available, a recommendation from the manufacturer should be requested. If unable to obtain this information refer to the paragraphs which cover the other methods listed above.

The "standard" fixed relationships of the Model 1224 or 1225 Monitor warning (W) and shutdown (SD) levels are: W = 2/3 SD, or SD = 1.5 W, and SD/W = 1.5. A manufacturer's recommended warning and shutdown levels will not necessarily be related in the same way. The important factor is that either the warning or shutdown level set on the monitor may be equal to or lower than the corresponding recommended value. To determine which recommended level should be used as the key for setting up the monitor, divide the recommended shutdown value by the recommended warning value. If the result is equal to or less than 1.5, use the recommended shutdown level as the monitor shutdown level. If the result is greater than 1.5, multiply the recommended warning level by 1.5 and use the resulting value as the monitor shutdown level. The following examples further illustrate this procedure.

1. Manufacturer's recommended values: Shutdown = 4 mils; warning = 3 mils. Dividing 4 by 3 equals 1.33. Since 1.33 is less than 1.5, set monitor shutdown level at 4 mils (the recommended

value). Monitor warning level will then be 2/3 x 4, or 2.7 mils, which is slightly lower than the recommended warning level.

2. Manufacturer's recommended values: Shutdown = 0.5 in/sec; warning = 0.3 in/sec. Dividing 0.5 by 0.3 equals 1.67. Since 1.67 is greater than 1.5, set monitor shutdown at 1.5 x 0.3, or 0.45 in/sec. Monitor warning level will be 0.3 as recommended; shutdown level will be slightly lower than recommended.

Monitoring Two or More Machines

If a scanner is used to enable monitoring of two or more machines the "normal" and "warning" levels must be determined for each machine involved. For equal monitoring protection, the warning levels determined for all the machines should be very nearly the same. If the levels are slightly different, the lowest warning level must be set up on the monitor. If the differences in levels are too great, the warning level for one machine may be lower than the normal level of another; such an arrangement can not be used unless the lower warning level is raised, which in some cases may not be desirable.

Use of the monitor's shutdown function may be feasible when monitoring more than one machine. That is, it may be desirable to shut down all the machines being monitored in order to protect an endangered machine. With appropriate external circuitry, the shutdown relay can be used to control the desired simultaneous shutdown. The shutdown level chosen should be the lowest determined for all the machines involved.

Determining Levels From Vibration Severity Chart

The Mechanalysis General Machinery Vibration Severity Chart shown in figure 11 may be used as a general guide in selecting either a warning level, or a shutdown level. (Determining one of these levels automatically determines the other.) The chart applies to most rotating machinery. For the Model 1224 which monitors vibration displacement, select the value to be used at the frequency corresponding to the RPM of the machine. For the Model 1225 which monitors vibration velocity select a value from the velocity scale on the right of the chart. Note that the lines dividing the various regions of vibration severity are constant velocity lines.

Basing Levels on "Normal" Vibration Level

A widely used method of selecting warning and shutdown levels is to base them on the machine's normal vibration level. This method

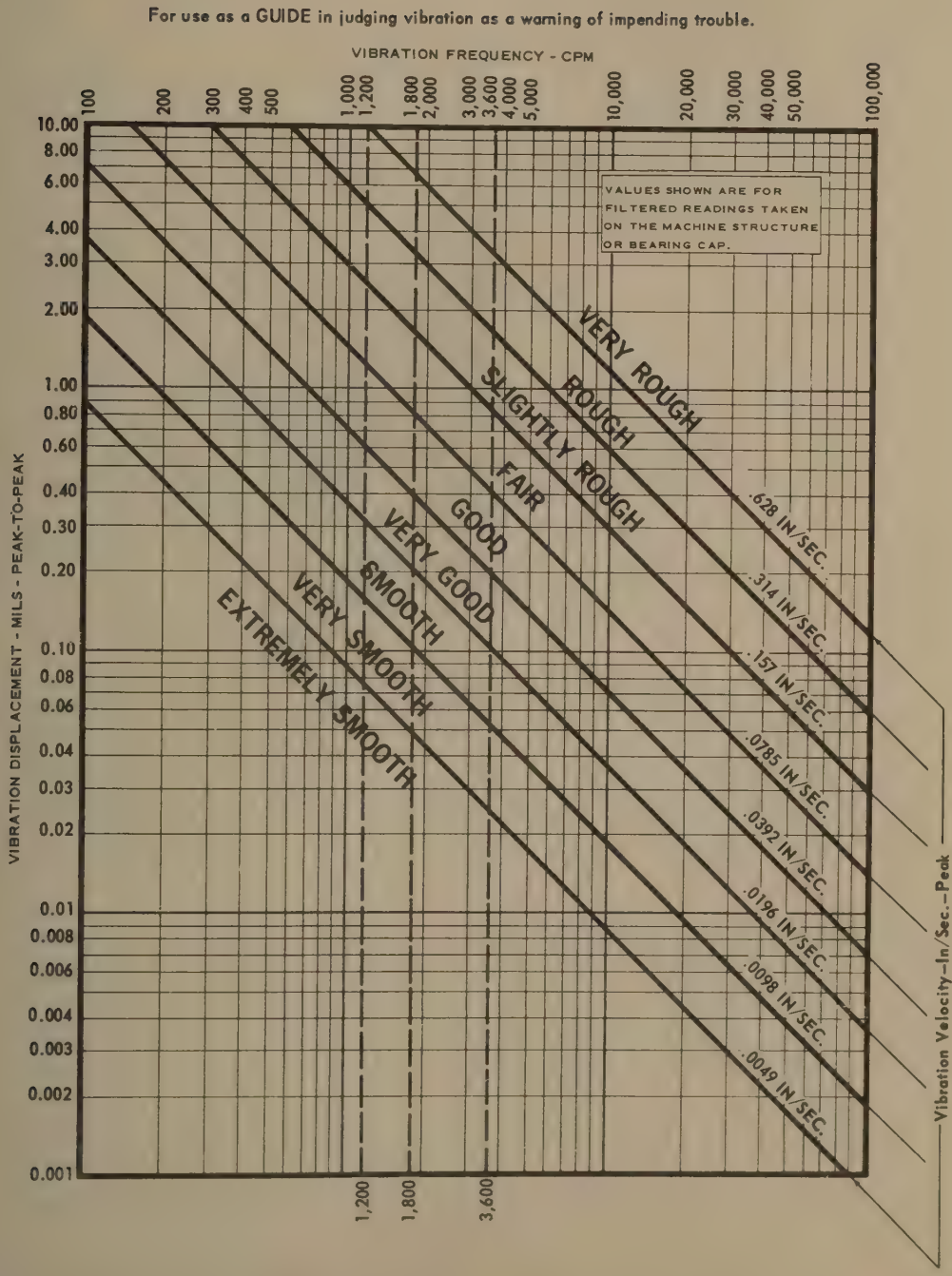


Figure 11. General Machinery Vibration Severity Chart

should be used only when it is reasonably certain that the machine's present condition is satisfactory. (Vibration analysis may be used to verify the condition of the machine.)

When trouble begins to develop in a machine, the vibration level will increase. The primary consideration in monitoring is to detect such increases as early as possible. By keeping the monitor warning level just slightly above the "normal" vibration level, an early warning is obtained, thus minimizing the amount of damage the trouble might cause. In cases where trouble is developing slowly, this early warning will permit scheduling of corrective action for a convenient time. Another advantage of using a relatively low warning level is that the shutdown level will also be relatively low. When using this approach the normal vibration increases due to load changes or other factors must be considered; if the warning level is below the level of such normal increases, unnecessary warnings will occur.

In some cases it may be desirable to use a somewhat higher warning level to permit a reasonable amount of sustained increase in vibration. As an example, this approach might be used where a certain amount of fan unbalance (due to blade erosion, or deposit build-up) can be tolerated before corrective action is necessary. Keep in mind, however, that using a higher warning level will necessitate a higher shutdown level.

The primary value of the monitor shutdown function is to protect the machine from possible damage or destruction when trouble develops too rapidly to take action after the warning has occurred. Thus, when selecting a warning level, the value of the related shutdown level should be carefully considered. If the related shutdown level is too high to provide the protection needed, it must be reduced. The warning level will of course be reduced proportionately.

SETTING WARNING AND SHUTDOWN LEVELS

After the shutdown level has been determined, the monitor is set up for that level as follows; (if warning level has been determined, multiply by 1.5 to obtain shutdown level):

1. If monitor is not operating, close switch or circuit breaker to turn on operating power.

2. Open access door. If monitor amplitude range switch is set for low range, and desired shutdown level is more than 5 mils (Model 1224) or 0.5 in/sec (Model 1225), set amplitude range switch to high range.

3. Depress SHUTDOWN RESET AND LEVEL ADJUST pushbutton. The resulting meter reading is the shutdown level; turn LEVEL ADJUST CW to increase level, or CCW to decrease level, as required. Release pushbutton.

4. Latch access door firmly.

NORMAL OPERATION

The following paragraphs describe the normal operating requirements for the monitoring system.

Using Startup Protection Switch

Assuming that the warning and shutdown levels have been determined and set, it can now be determined if use of the Startup Protection switch is required. Refer to the value recorded in step 13 of "Initial Testing." If this value (maximum vibration level during startup) is greater than 2/3 of the shutdown level, a warning sequence can be expected during startup, if the Startup Protection switch is not used. If the recorded value is greater than the shutdown level, the Startup Protection switch must be used during startup if an external shutdown device is installed.

Time Delay Adjustment

During initial use of the monitoring system, warning sequences may momentarily occur for no apparent reason. Shutdown sequences may also occur. These sequences may be the result of short-duration transient vibration. In many cases the normal effects of load changes, nearby machines, or nearby traffic, etc., will be the cause. (If possible, use vibration analysis to verify that these transients do not indicate trouble in the machine.) These unnecessary warnings or shutdowns can be minimized by adjusting the setting of the internal transient vibration TIME DELAY potentiometer - see figure 12. Access to this control is obtained by removing the four screws from the corners of the front panel, and sliding the panel/chassis assembly part-way out of the case. By changing the setting, transients are "damped" for a shorter or longer period. The TIME DELAY range is from 3 seconds (MIN) to 10 seconds (MAX). The control should be set for the minimum delay time which will still prevent an unwanted warning or shutdown.

Using Monitor SYSTEM TEST

The SYSTEM TEST function may be used periodically (daily, weekly,

etc.) and at any time system problems are indicated or suspected. The correct indication (with SYSTEM TEST depressed) is a meter reading within the green TEST area. The test checks out the signal processing circuitry in the monitor, the pickup cable and the pick-up. If a scanner is installed, the SYSTEM TEST pushbutton must be held in for at least 60 seconds to check out all pickups and their cables.

In many cases the warning level (and possibly the shutdown level) will be at or below 50% of full scale. If so, when the SYSTEM TEST pushbutton is depressed a warning sequence will occur and the SHUTDOWN light may come on. If the SHUTDOWN light does come on, the shutdown relay and external shutdown device can not be actuated due to the open SHUTDOWN INTERLOCK switch (with access door open). Operation of the warning sequence (and SHUTDOWN light) is not detrimental - in fact, if these sequences occur it is an additional check of the overall system. However, one important fact must be remembered:

CAUTION

If SHUTDOWN light comes on when using SYSTEM TEST, the SHUTDOWN RESET AND LEVEL ADJUST pushbutton must be momentarily depressed to reset shutdown circuitry, before closing access door. If not reset, an unwanted shutdown will occur when the access door is closed.

Figure 12. TIME DELAY Potentiometer Location

INCORRECT SYSTEM TEST READOUT

If an incorrect SYSTEM TEST readout is obtained, the value of the readout may be helpful in determining the cause, as follows:

Readout near zero	1. Probable short circuit between signal and return leads in pickup cable or at cable terminal connections. 2. Possible short circuit in pickup or monitor.
Readout near full scale	1. Check for poor connection in pickup cable signal or return lines (at pickup connector, safety barrier, scanner or monitor). 2. Possible open circuit in pickup cable. 3. Possible open circuit in pickup or monitor.
Readout in area of 10 to 30% of full scale, or 70 to 90% of full scale	1. Check for partial short- or poor connection in signal or return lines. 2. Possible malfunction in signal processing circuitry.
Readout just slightly above or below TEST area	1. Slightly high reading may be normal if pickup is located in high-temperature area (over 250°F). Make pickup resistance test; refer to "ADJUSTING TEST SIGNAL LEVEL" in CALIBRATION section. 2. Calibration of monitor may be required. (Refer to CALIBRATION Section.) However, all resistance tests are recommended before calibrating.

If correcting any loose or faulty connection does not solve the problem, determining which of the components is faulty is accomplished by the following resistance tests. A Simpson Model 260 multimeter, or the equivalent, may be used.

Pickup Resistance Test

Disconnect the pickup cable from the pickup. Measure resistance between pins A and B of connector on pickup to be 2000 (±200) ohms. (If pickup is or was located in temperature of 250°F or more, reading may be high; if necessary, allow to cool.) If not correct return pickup to factory.

Cable and Monitor Resistance Tests

Confirm that no connections of any kind are made to ANALYZER jack on monitor. Disconnect pickup cable connector from pickup.

CAUTION

If a safety barrier is installed, temporarily connect a jumper across terminals 1 and 4 of barrier during following tests to prevent possible damage to barrier. Be sure to remove jumper after making tests.

Measure the resistance between pins A and B of connector on cable, still connected through other system components (scanner and/or jumpered safety barrier, if installed) to monitor. Measurement should be between 123K ohms and 151K ohms.

If resistance is either infinite or near zero an open or short circuit exists. Disconnect cable at monitor (terminals 1 and 10) and troubleshoot cable as necessary to locate. If scanner is installed, check continuity of signal and return lines through scanner; refer to schematic in scanner handbook.

If resistance is neither infinite, near zero, or within limits given, check resistance directly across terminals 1 and 10 of monitor, with signal input cable disconnected. If reading is not between 123K ohms and 151K ohms, return monitor to factory.

If trouble with safety barrier is suspected, check as follows. Remove pickup from hazardous area and connect all components as for normal installation. Repeat SYSTEM TEST with and without jumper connected to barrier terminals 1 and 4. Test readout with jumper connected should be just slightly lower than with jumper disconnected. If results are satisfactory, be sure that jumper is disconnected before reinstalling pickup. If results are not satisfactory, return barrier to factory.

CALIBRATION

Calibration of the monitor consists of adjusting the gain of the signal processing circuit to obtain a specific amplitude meter reading, when a calibrated input signal is applied. Test equipment required is an audio signal generator (Hewlett-Packard 202C or equivalent) and a VTVM (Hewlett-Packard 403A or equivalent). Calibration of the monitor will generally require readjustment of the level of the test signal applied when the SYSTEM TEST function is used.

AMPLITUDE CALIBRATION

The nominal output of a Model 544 pickup is approximately 240 millivolts rms, when subjected to a vibration of either 1 mil peak-to-peak displacement or 0.314 in/sec peak velocity, at a frequency of 100 Hz. This output voltage will change directly in proportion to changes in displacement or velocity, at the same frequency.

The pickup input signal to the monitor is simulated with the signal generator. Figure 13 shows the test setup. To obtain an input to the monitor which will result in the most accurate meter reading (80% of full scale), a higher amplitude than the nominal 240-millivolt pickup output is used. The initinal steps of the procedure determine the exact amplitude required.

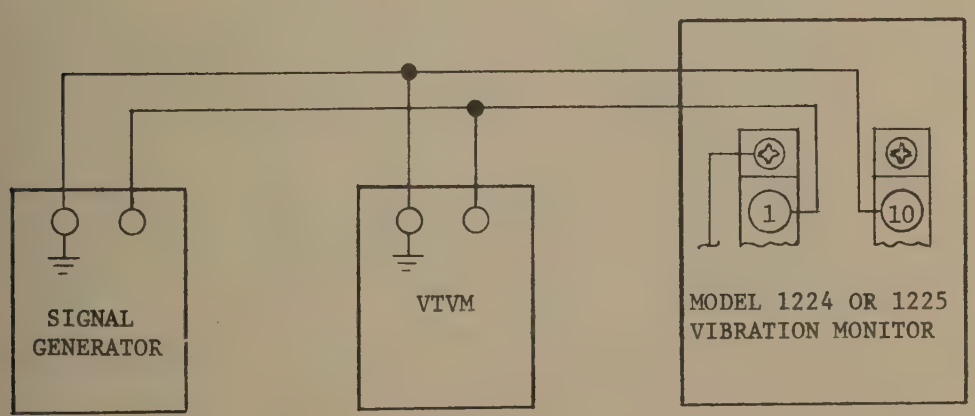


Figure 13. Calibration Setup

NOTE

Certain pickups have their exact "calibration" output value indicated in their serial numbers. These values should be used in the following procedure when available.

1. Determine simulated pickup voltage (PVcal) to be used for calibration, using step 2 or 3 as applicable.

2. If serial-number prefix letter of any pickup used with monitor is A or B, or if there is no prefix letter:

a. For calibration of Model 1224 monitor, use PVcal = 960 millivolts.

b. For calibration of Model 1225 monitor, use PVcal = 306 millivolts.

3. If all pickups to be used with monitor have serial numbers with prefix letter C or latter, determine PVcal (millivolts) as follows:

a. If only one pickup is used with monitor, record last three digits of serial number as PVavg (millivolts). (This is the 1-mil, 100-Hz output of the pickup.) Refer to step c or d.

b. If more than one pickup is used with monitor, record last three digits of the serial numbers as PV1, PV2, PV3, and PV4, as applicable. Now average the values recorded, e.g.,

$$\frac{PV1 + PV2}{2} = PVavg, \quad \text{or} \quad \frac{PV1 + PV2 + PV3 + PV4}{4} = PVavg$$

Refer to step c or d.

c. For calibration of Model 1224, use PVcal = 4 x PVavg. (Result should be within range of 900 to 1075 millivolts.)

d. For calibration of Model 1225, use PVcal = 1.274 x PVavg. (Calculate carefully; result should be within range of 287 to 325 millivolts.)

4. Turn off power to monitor. Set amplitude range switch to low range.

5. Connect signal generator, VTVM and monitor as shown in

figure 13. (Disconnect pickup input cable normally connected to terminals 1 and 10.) Set signal generator for minimum output amplitude and set frequency at 100 Hz.

6. Arrange monitor chassis so that GAIN ADJUST potentiometer can be adjusted with power applied - see figure 14.

CAUTION

Use care in working with open chassis while power is applied.

7. Turn on power to monitor and test equipment, and allow 5 minutes for warmup.

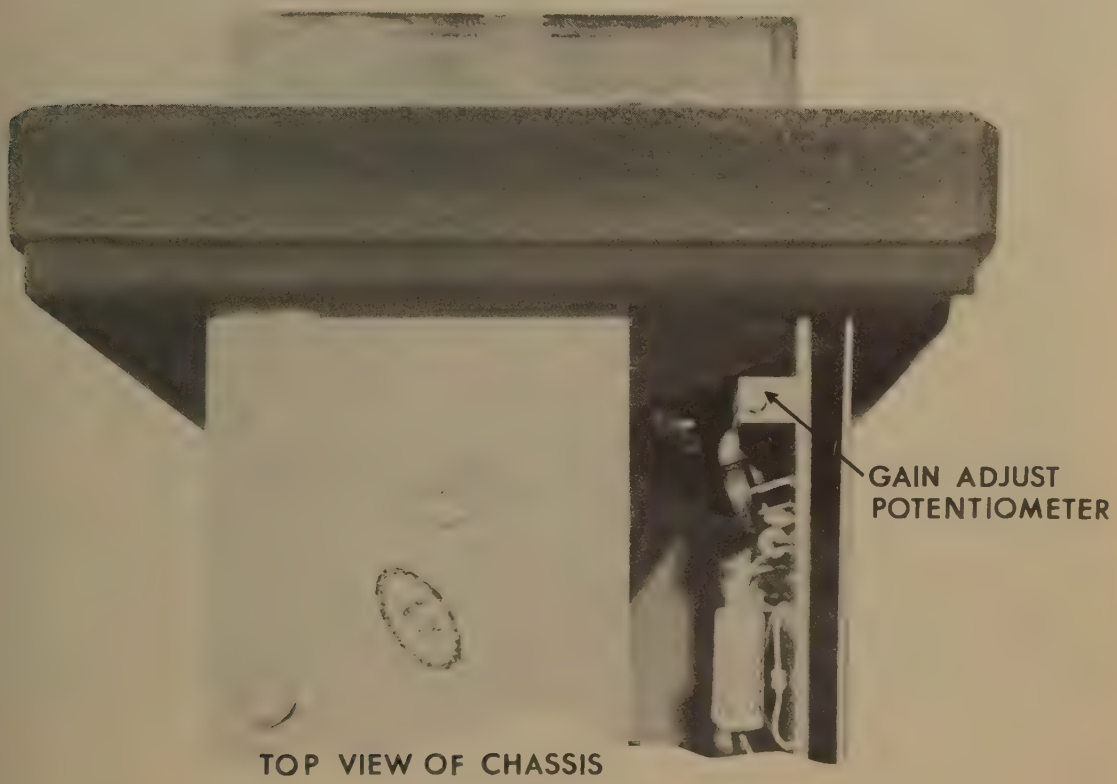


Figure 14. GAIN ADJUST Potentiometer Location

8. Set signal generator output amplitude (as indicated on VTVM) to the "PVcal" value determined in step 2 or step 3.

9. Set GAIN ADJUST potentiometer as required to obtain an amplitude meter reading of exactly "4" on the lower meter scale.

10. Turn off power to monitor and test equipment. Disconnect test equipment.

11. Reconnect pickup input cable to terminals 1 and 10. Pick-up should be connected to pickup cable.

12. Arrange chassis so that TEST SIGNAL ADJUST potentiometer can be reached with adjustment tool when power is applied. Access is through hole in rear of chassis next to terminal 14 - see figure 15.

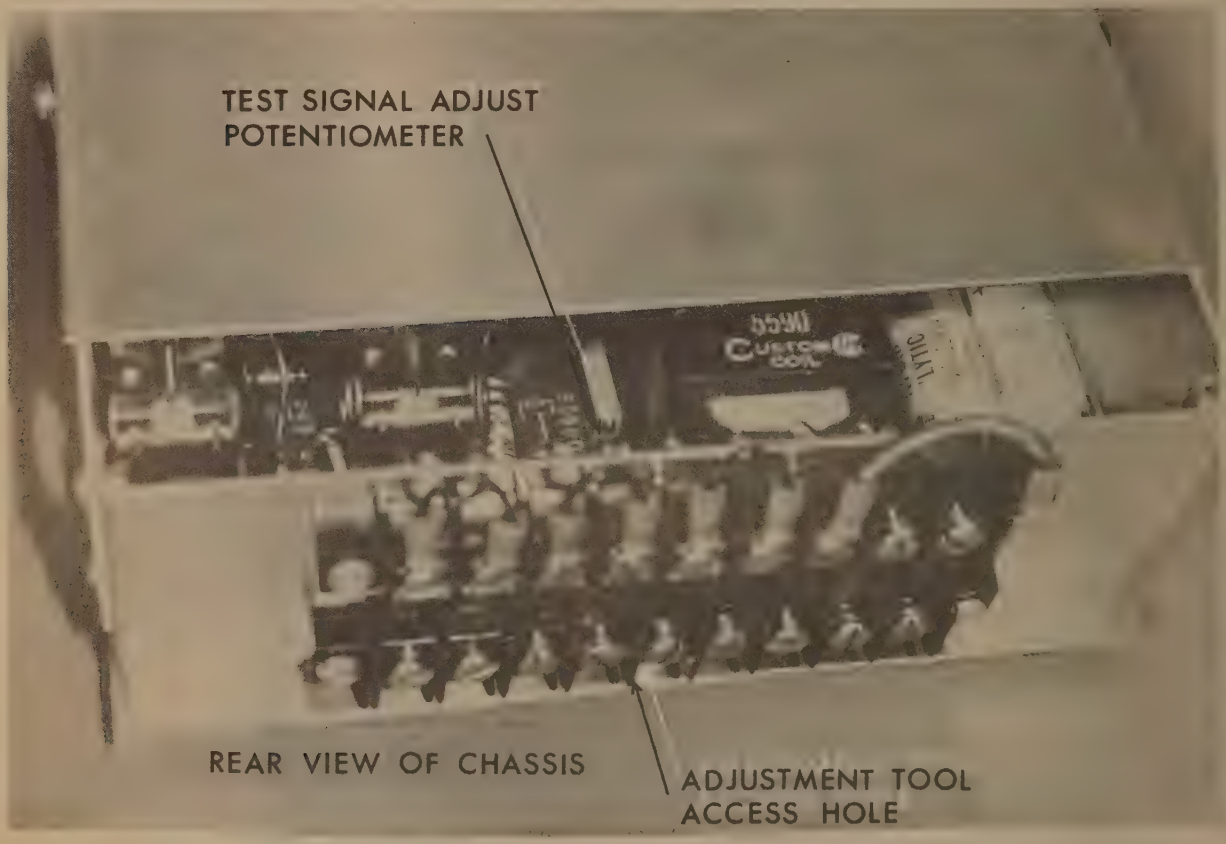


Figure 15. TEST SIGNAL ADJUST Potentiometer Location

CAUTION

Adjustment tool to be used must have insulated shank and handle. Try tool for fit before turning on power.

- Use care in working with open chassis while power is applied.

13. Turn on power to monitor and allow 5 minutes for warmup.

14. Depress STSTEM TEST pushbutton and set TEST SIGNAL ADJUST potentiometer as required to obtain an amplitude reading of exactly 7.5 on the upper meter scale. If scanner is installed, place in "SCAN" mode and confirm that reading stays in TEST area throughout each 60-second scan cycle. If a given channel produces a reading slightly out of the TEST area, a "compromise" setting of TEST SIGNAL ADJUST may be made.

15. Turn off power to monitor and reinstall chassis.

ADJUSTING TEST SIGNAL LEVEL

Normally, adjustment of the test signal level (for changing SYSTEM TEST readout) should not be performed unless the monitor has just been calibrated. For this reason this adjustment is included as the last part of the preceding amplitude calibration procedure. However, for some specific installations the SYSTEM TEST readout may initially be slightly high or low. For this case only, slight correction of the readout may be made without performing the complete calibration precedure - perform only steps 10 through 15.